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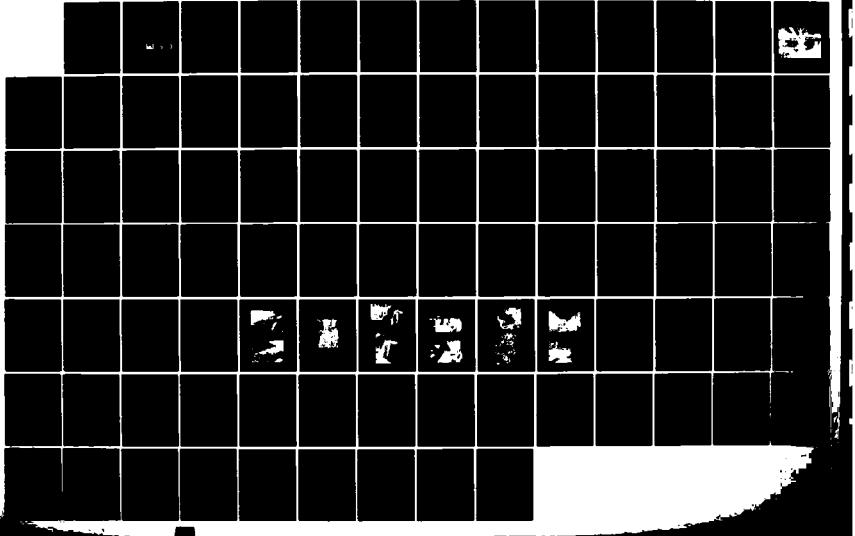

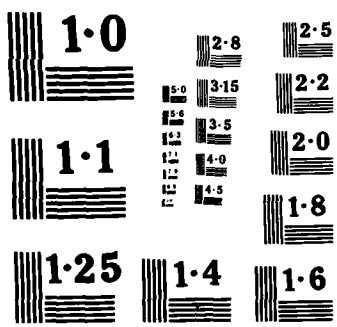

PISCATAQUA RIVER BASIN
DURHAM, NEW HAMPSHIRE

PACKERS FALLS DAM

NH 00441

NHWRB 71.04

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DECEMBER 1980

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:
NEDED

MAY 19 1981

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

Inclosed is a copy of the Packers Falls Dam (NH-00441) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, City of Durham, City Hall, Durham, New Hampshire 03824.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Piscataqua River Basin
Durham, New Hampshire
Lamprey River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

TXe dam is a 17.8 ft. high concrete gravity structure with two low embankments and an old mill race gate structure. THe dam is about 200 ft. long. It is small in size with a significant hazard potential. the 100 year flood has been adopted as the appropriate test flood. The dam is in fair condition at the present time. There are various remedial measures which the owner should implement.

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NATIONAL DAM INSPECTION

PHASE I INSPECTION REPORT

Identification No.:	NH 00441
NHWRB No.:	71.04
Name of Dam:	Packers Falls Dam
Town:	Durham
County and State:	Strafford, New Hampshire
Stream:	Lamprey River
Date of Inspection:	November 6,1980

BRIEF ASSESSMENT

The Packers Falls Dam is located on the Lamprey River, approximately one mile upstream of the village of Packers Falls in Durham, New Hampshire. Wiswell Road crosses the Lamprey River approximately 500 feet upstream of the dam.

The dam is a 17.8 foot high concrete gravity structure with two low embankments and an old mill race gate structure. The concrete gravity section consists of a run-of-the-river spillway, 110 feet long, and a concrete outlet structure with two gates. The gates are each 5 feet high by 6 feet wide. The dam is approximately 200 feet long.

The dam was originally built in 1911 to provide hydroelectric power for the Rockingham County Light and Power Company. The dam presently impounds water for use as a water supply for the Town of Durham and the University of New Hampshire. It is owned by the Town of Durham.

The drainage area for the dam covers approximately 183 square miles of rolling, forested terrain with some minor development and pasture.

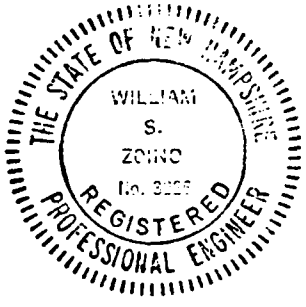
The Packers Falls Dam is SMALL in size and its hazard potential classification is SIGNIFICANT since appreciable economic loss and possible loss of a few lives could result in the event of dam failure. The appropriate test flood for a dam classified SMALL in size with a significant hazard classification would be between the 100-year flood and one half of the Probable Maximum Flood. Since the risk downstream is on the low side of the significant classification, the 100-year flood has been adopted as the appropriate test flood.

The analysis in Appendix D shows a peak 100-year outflow of 7,055 cfs, with the water surface at 62.2 feet NGVD, which is 1.7 feet above the top of the dam. The spillway is capable of passing 66 percent of the Test Flood outflow before overtopping.

The dam is in FAIR condition at the present time. It is recommended that the owner retain the services of a qualified registered professional engineer to perform detailed hydraulic and hydrologic investigation to further define the need for and means to increase the project discharge capacity or its ability to withstand overtopping, and to evaluate the need and make recommendations for the redesign or replacement of the right corewall, and to evaluate the spalled concrete, misaligned steel sluice gate, abandoned mill race, and the effect of the use of flashboards on the structural stabilitiy of the dam. The spillway section should be inspected under low flow conditions. The engineer should also make recommendations for the removal of trees from the embankments.

Remedial measures to be undertaken by the owner include removing brush from embankment slopes, implementing an annual maintenance and inspection programs, and developing a written warning system for downstream residents in the event of an emergency.

These engineering studies and remedial measures should be implemented by the owner within one year of receipt of this Phase I Inspection Report.



William S. Zoino
NH Registration No. 3226

Nicholas A. Campagna, Jr.
California Registration No. 21006

This Phase I Inspection Report on Packers Falls Dam (NH-00441) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH W. FINEGAN, JR., CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

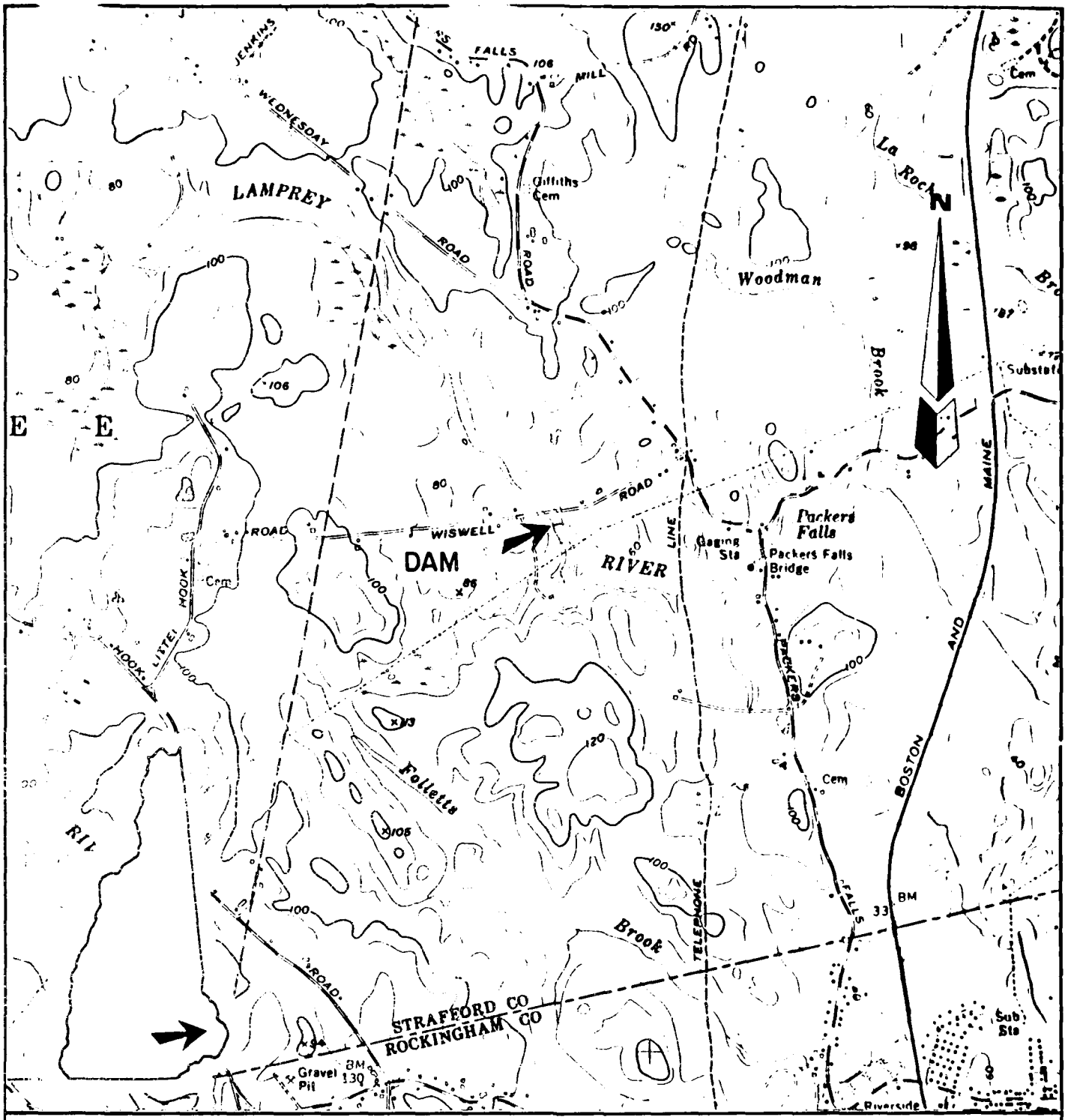
TABLE OF CONTENTS

TABLE OF CONTENTS - (cont.)

TABLE OF CONTENTS - (cont.)

APPENDICES

Overview of Dam



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FROM USGS NEW MARKET - N.H. QUADRANGLE MAP

GOLDBERG · ZOINO & ASSOCIATES, INC. GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS NEWTON UPPER FALLS, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION PLAN

FILE No. 2605

PACKER FALLS DAM , DURHAM, NEW HAMPSHIRE

SCALE AS SHOWN

DATE

National Dam Inspection Program

Phase I Inspection Report

Packers Falls Dam

Section I: Project Information

1.1 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Progam of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg-Zoino & Associates, Inc. (GZA) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to GZA under a letter of September 23, 1980 from Colonel William E. Hodgson, Jr., Corps of Engineers. Contract NO. DACW 33-80-C-0055 has been assigned by the Corps of Engineers for this work.

(b) Purpose

1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

3) Update, verify, and complete the National Inventory of Dams.

1.2 Description of Dam

(a) Location

The Packers Falls Dam is located on the Lamprey River approximately one mile upstream of the village of Packers Falls in Durham, New Hampshire. It can be reached from Wiswell Road which crosses the Lamprey River just upstream of the dam.

The dam is shown on USGS Newmarket-NH quadrangle at approximately coordinates N4306.2, W7057.8 (see location map on Page vi). Page B-2 of Appendix B is a site plan for this dam.

(b) Description of Dam and Appurtenances

Packers Falls Dam is a 17.8-foot-high concrete gravity dam with two low earth embankments and an old mill race gate structure. The concrete gravity section contains a run-of-the-river spillway and a concrete outlet structure with two gates. The overall length of the dam is approximately 200 feet, of which 110 feet is spillway. The dam consists of the following components:

1) Right Embankment (see Page B-4)

At the right abutment is a 19-foot-long, 4-foot-high earth embankment with a 12-inch-thick unreinforced concrete corewall. The corewall extends about 1 foot above the earth fill on the upstream side and about 3-1/2 feet above the earth fill on the downstream side. Both up and downstream slopes are irregular and average approximately 1 vertical to 3 horizontal.

2) Right Spillway End Wall (see Pages B-2 and B-4)

The right concrete corewall abuts a concrete end wall which is 2-1/2 feet wide by 13.5 feet long. This end wall is part of the concrete gravity spillway. The top of the end wall is at Elevation 60.5 feet (NGVD). This elevation has been adopted as the top of the dam. There is rubble stone masonry training wall extending downstream from this end wall for approximately 20 feet.

3) Spillway (see Pages B-2, B-4, and B-5)

The spillway is a concrete ogee structure founded on bedrock. The crest is 110 feet long with crest elevation 55.7 feet (NGVD). There are three concrete buttresses, roughly at the quarter points of the spillway on the downstream side. They are about 1 foot wide by 6 feet long and 1 foot deep.

4) Gate Structure (see Pages B-2, B-4 and B-5)

At the left end of the spillway is a concrete gate structure with two outlet gates. The wasteway openings are 5 feet high by 6 feet wide with invert elevations at 48.0 feet (NGVD). The gates are of aluminum and steel with 2-inch-diameter stainless steel riser stems. The hoisting equipment are two crank-operated floor stands mounted on steel wall brackets.

The gate structure is concrete with a more recent layer of pneumatically applied mortar (gunite) over the entire surface. The top of this structure is about 3.5 feet wide by 20 feet long and ties directly into a concrete end wall at the left end.

5) Left End Wall (See Pages B-2 and B-4)

The left concrete end wall is approximately 11 feet long by 2 feet wide with the top at elevation 60.8 feet (NGVD). The sides of the end wall have a recent coating of pneumatically applied mortar. Extending downstream from this end wall is a rubble masonry training wall. The portion of this wall within 10 feet of the end wall has also been covered with pneumatically applied mortar. The training wall extends several hundred feet downstream.

6) Left Embankment (see Pages B-2 and B-4)

To the left of the end wall is a 30-foot-long earth embankment with a 12-inch thick concrete corewall. This earth embankment is approximately 4 feet high with crest elevation approximately 60.8 feet (NGVD). The upstream and downstream slopes appear to be approximately 1 vertical to 2 horizontal.

7) Mill Race Gate Structure (see Pages B-2, B-4, and B-5)

At the left end of the left embankment is a reinforced concrete mill race gate with three gate openings. The mill race canal upstream of this gate structure has been partially filled with earth. The hoisting mechanism and gate stems for the old wooden gates have been removed. The partially deteriorated old wooden gates are still in place but are no longer operable. Extending downstream from the gate structure is an old mill race canal which is no longer used. The canal is approximately 10 feet wide with vertical stone masonry walls on either side.

If flood stage reaches sufficient height, the partially filled mill race canal may be overtopped prior to overtopping of the dam. It is probable that failure of this fill section would wash out the timber gate structure as well.

(c) Size Classification

The dam has a maximum impoundment of 500 acre-feet and a height of 17.8 feet. According to the Corps of Engineer's Recommended Guidelines, a small size dam is one with a maximum storage between 50 and 1000 acre-feet or a height between 25 and 40 feet. Therfore, this dam is classified as small in size based on its storage.

(d) Hazard Potential Classification

The hazard potential classification for this dam is SIGNIFICANT because of the appreciable economic losses and potential for loss of a few lives downstream in the event of dam failure. There are two houses located 2,200 feet and 3,000 feet downstream which could be affected by the dam failure flood. The prefailure flow conditions would cause no flooding, but the post-failure flow would cause 1-2 feet of flooding above the first floor level in the first home and 4-5 feet of flooding above the first floor level in the second home.

(e) Ownership

The dam is presently owned by the City of Durham, New Hampshire. It is controlled by the Department of Public Works, Durham, New Hampshire, 03824.

(f) Operator

The operation of the dam is controlled by the Department of Public Works. The Public Works Director, Mr. George Crombie can be reached by telephone at (603) 868-5571

(g) Purpose of the Dam

The dam was originally constructed to provide hydroelectric power. At present, the sole purpose of the dam is to impound water to be used as water supply for the Town of Durham and the University of New Hampshire.

(h) Design and Construction History

The dam was originally constructed in 1911 to provide hydroelectric power for the Rockingham County Light and Power Company. Some repair work at the gate structure was undertaken in 1966 although all of the work shown on the design drawings was not completed.

(i) Normal Operating Procedures

No formal operating procedures exist for this dam. The steel waste gates are normally closed. The abandoned timber sluice gates are inoperable.

1.3 Pertinent Data

(a) Drainage Area

The drainage area for this dam covers 183 square miles. It is made up primarily of rolling woodland and pasture.

(b) Discharge at Dam Site

1) Outlet Works

The outlet works for this dam consists of two steel gated wasteways at the left abutment. These are each 5 feet wide by 5 feet high with inverts at Elevation 48.0 feet (NGVD). The capacity of these gates with the reservoir at top of dam elevation (60.5 feet NGVD) is 1,644 cfs.

2) Maximum Known Flood

Based on the flows recorded at a gauging station downstream of the dam, the maximum known flood occurred in March, 1936, with a flow at the dam of approximately 5,590 cfs. A flood of 5,000 cfs occurred in March 1977.

3) Ungated Spillway Capacity at Top of Dam

The capacity of the spillway with the reservoir at the top of the dam elevation (60.5 feet NGVD) is 4,650 cfs.

4) Ungated Spillway Capacity at Test Flood

The discharge capacity above the spillway at the test flood elevation (62.2 feet NGVD) is 6,600 cfs.

5) Gated Spillway Capacity at Normal Pool

There are no gated spillways.

6) Gated Spillway Capacity at Test Flood

There are no gated spillways

7) Total Spillway Capacity at Test Flood

The capacity of the spillway at Test Flood elevation (62.2 feet NGVD) is 6,600 cfs.

8) Total Project Discharge at Top of Dam

The total project discharge at top of dam elevation (60.5 feet NGVD) is 4,650 cfs.

9) Total Project Discharge at Test Flood Elevation

The total project discharge at Test Flood elevation (62.2 feet NGVD) is 7,055 cfs.

(c) Elevation (feet NGVD)

1) Streambed at toe of dam: Approximately 42.7

2) Bottom of cutoff: Unknown

3) Maximum tailwater: Unknown

4) Normal Pool: Approximately 55.7

5) Full flood control pool: Not applicable

6) Spillway crest: Approximately 55.7

7) Design surcharge: Unknown

8) Top of dam: 60.5

9) Test flood surcharge: 62.2

(d) Reservoir (length in feet)

This is a run of the river dam with a reservoir length of approximately 7,000 feet.

(e) Storage (acre-feet)

1) Normal Pool: 360

2) Flood Control Pool: Not applicable

3) Spillway Crest Pool: 360

4) Top of Dam Pool: 500

5) Test Flood Pool: 560

(f) Reservoir Surface (acres)

This is a run-of-the-river dam with a reservoir surface area of 30 acres.

(g) Dam

1) Type: Gravity, overflow, concrete

2) Length: Approximately 200 feet

3) Height: Approximately 18 feet

4) Top width: Approximately 4 feet, variable

5) Side slopes: Left Embankment: 1 vertical to 2 horizontal
Right Embankment: 1 vertical to 3 horizontal

6) Zoning: Not applicable.

7) Impervious Core: Not applicable

8) Cutoff: Unknown

9) Grout curtain: Unknown

(h) Diversion and Regulating Tunnel

Not applicable

(i) Spillway

1) Type: Concrete, broad crested weir

2) Length of weir: 110 feet

3) Crest elevation: 55.7 feet (NGVD)

4) Gates: Spillway not equipped with gates

5) Upstream channel: Lamprey River

6) Downstream channel: Lamprey River

(j) Regulating Outlets

The regulating outlets at this dam consist of two 5 foot by 6 foot wasteways equipped with vertical stem steel slide gates. The invert elevation of these wasteways is 48.0 feet (NGVD). The water supply outlet is located more than one half mile upstream. It is normally closed, having been used only twice in the last ten years according to the owner.

Section 2: Engineering Data

2.1 Design Data

None of the original design drawings or calculations are available for this dam. Lacking are data concerning the length and depth of any cutoff and the foundation conditions, and the cross section of the spillway. Available data include preliminary design drawings for the 1966 repairs. These were drawn by Camp, Dresser & McKee Consulting Engineers of Boston, Massachusetts and dated March, 1966. Also available are the specifications for this work, dated April, 1967. Some early inspection reports are available and have been included in Appendix B of this report.

2.2 Construction Records

No construction records are available for this dam.

2.3 Operational Records

No operational records are available for this dam.

2.4 Evaluation of Data

a) Availability

There is no detailed design or construction data available for evaluation.

(b) Adequacy

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment of the dam is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Validity

The observations of the inspection team generally confirm the information contained in the records of the New Hampshire Water Resources Board. However, the preliminary design drawings for the repair work show some work items which apparantly were not accomplished. In particular, the placement of backfill around the abandoned gate structure indicated on Sheet No. 2 of the preliminary drawings has not been accomplished (see page B-4 and C-7 of this report). Indicated repairs to the right abutment have not been accomplished. Caution must be taken in reliance on any data contained on these drawings and specifications without a thorough examination.

Section 3: Visual Inspection

3.1 Findings

(a) General

The Packers Falls Dam is in FAIR condition at the present time.

(b) Dam

(1) Right End Wall (see Photos 3, 4, and 5)

The concrete right end wall, which was treated with pneumatically applied mortar, has been subjected to spalling over approximately 75 percent of its exposed surface area. The remaining portion of this wall has been subjected to random cracking. The spalling and cracking can be attributed to poor quality control of mortar application and subsequent deterioration. This deterioration resulted in moisture intrusion and subsequent freeze-and-thaw cycles caused further deterioration. The interface of the end wall and the spillway has eroded in excess of 12 inches which can be attributed to cavitation and subsequent ice damage.

The downstream extension of this wall, which consists of dry rubble stone masonry, is in fair condition with no evidence of settlement, bulging, or distress. However, there are large voids in this wall.

The concrete core wall which extends into the right embankment has been subjected to partial failure. The center section of this wall has sheared from the adjacent sections and is leaning in the downstream direction. It has displaced up to 6 inches.

(2) Spillway (see Photos 1 and overview)

The spillway was inspected under high flow conditions. It is a concrete structure founded on bedrock which was repaired with an application of pneumatic mortar. There are two continous horizontal construction joints in the mortar application which have been subjected to spalling. These horizontal joints are located approximately 1 foot and 10 feet below the crest of the spillway. A considerable amount of pneumatic mortar has been eroded from the downstream face of the spillway. The deterioration can be attributed to ice damage.

Pipe sockets for flashboard stanchions are located along the entire length of the spillway crest, but flashboards are not used.

(3) Waste Gate Structure (Steel Gates) (see Photos 6 and 7)

This is a concrete structure which was repaired with an application of pneumatic mortar. This structure has been subjected to a high degree of spalling on its upstream face and the

intermediate buttress on the downstream side. There is considerable random cracking and efflorescence over the entire surface of the pneumatically applied mortar. This condition also applies to the roofs and walls of the outlet tunnels. A high concentration of stalactites were observed hanging from the outlet tunnel roofs. The overall spalling and cracking condition can be attributed to moisture intrusion subjected to alternate freeze-and-thaw cycles.

Observations of the bench stands revealed that the left stand is misaligned and tilting downstream. The misaligment has caused binding in the gate which precludes complete seating. Seepage is approximately 1 cfs of clear flow. Observations of the gates from the downstream tunnels revealed that they are in good condition, but appear to be inoperable. The gate operating wheels are stored off-site in order to prevent unauthorized use.

(4) Left End Wall (see Photo 8)

The left end wall is a concrete structure which was repaired with an application of pneumatic mortar. With the exception of minor surface cracking, this wall is in good condition with no evidence of surface spalls or efflorescence.

(5) Left Embankment Core Wall (see Photo 9)

This concrete structure is in good condition with the exception of minor surface cracks. There is no evidence of surface spalls or efflorescence.

(6) Mill Race Gate Structure (Timber gates) (see Photos 10 and 11)

This reinforced concrete structure has been subjected to a considerable degree of surface spalling on both the upstream and downstream faces. Reinforcing steel is exposed and rusted. Observations revealed that this structure houses three timber sluice gates. The timber stems of these gates have been cut off approximately 8 feet below the concrete platform. All operating mechanisms have been removed. The forebay entrance has been partially filled with earth. Standing water was observed downstream of this structure which may be seepage although no visible flow was noted.

The downstream canal walls consist of dry stone masonry. These walls are in good condition.

(c) Reservoir Area (see overview photo)

The reservoir is the Lamprey River channel. The shores of the channel are generally shallow sloping woodland. They appear to be stable and in good condition.

The Wiswell Road crosses the reservoir approximately 150 to 200 feet upstream of the dam. The bridge consists of two simply supported spans of approximately 30 feet each. The spans are Steel I Beam construction and are supported on granular fill.

(d) Downstream Channel (see Photo 2)

The downstream channel is the Lamprey River channel. In general, it is stable, and in good condition.

3.2 Evaluation

The dam and its appurtenant structures are generally in fair condition. The problem areas noted during visual inspection are listed as follows:

(a) Spalled concrete and deterioration of pneumatic mortar at right end wall and gate structure.

(b) Misalignment of left sluicegate and its operating mechanism.

(c) Failure of right core wall.

(d) The spillway should be inspected under low flow conditions.

(e) Trees and brush growing on embankments.

(f) Possible use of flashboards and their effect on structural stability.

(g) Possible failure of mill race canal prior to dam overtopping.

Section 4: Operational and Maintenance Procedures

4.1 Operational Procedures

(a) General

No written operational procedures exist for this dam. The outflow is normally uncontrolled. The water supply outlet is approximately one half mile upstream of the dam. From this pumping station, the water is carried through pipes to a small reservoir on the Oyster River. It is intended to serve as an emergency (drought) water supply, however, according to a town official, this water supply has not been used for at least five years. The operability of the pumps was last checked two or three years ago.

(b) Description of any Warning System in Effect

There is no downstream warning system in effect at this dam.

4.2 Maintenance Procedures

(a) General

No formal maintenance program exists for this dam, and maintenance is performed infrequently.

(b) Operating Facilities

No formal maintenance program exists, and maintenance is performed infrequently.

4.3 Evaluation

Emphasis on routine maintenance will assist the owner in assuring the long-term safety of the dam and operating facilities. A formal, written, downstream emergency warning system should be developed for this dam.

Section 5: Evaluation of Hydraulic/Hydrologic Features

5.1 General

The principal spillway for Packers Falls dam is 110 feet wide with a height of about 12 feet above the streambed. The dam also has two 5-foot high by 6-foot wide sluice gates. The impounding capacity at normal pool is 360 acre-feet, with a maximum impounding capacity of 500 acre-feet.

In the left overbank area are the remains of an old bypass structure which is blocked with fill and no longer used. The overbank on either side is heavily wooded. The stream slopes very gradually for approximately 3,200 feet downstream of the dam to the location of a stream gauging site discussed in Section 5.3. Just downstream of the gauge, the river gradient increases sharply. About 200 feet downstream of the gauge is a 36 foot wide by 18 foot high concrete arch bridge in relatively good condition. During the flood of 1977, which produced a flow of about 5,000 cfs, the arch was about half full.

After the Packers Falls Bridge, the river again takes on a flat gradient, and the river banks become wider. The hydrologic storage increases as the Lamprey River approaches the sea and the low-lying area becomes marshy. The river eventually reaches Newmarket, about 3 miles downstream of the dam.

5.2 Design Data

Data sources for Packers Falls Dam included preliminary plans of the dam site before general maintenance improvements were made in 1966. Also available is the New Hampshire Water Resources Board's January 29, 1980 "Inventory of Dams in the United States" and a 1939 sketch. Copies of this material can be found in Appendix B of this report.

5.3 Experience Data

Located about 3,000 feet downstream of the dam is a U.S. Geological Survey stream gauging site. The difference in drainage area between the two sites is minimal and for the purposes of this report will be neglected. Stream gauge records at the Lamprey River site are excellent with a period of record from July 1934 to the current year. The greatest discharge recorded at the site is 5,590 cfs, which occurred in March of 1936. Another high discharge (5,000 cfs) was recorded in 1977 and flood notes were taken by the stream gauge operator for the surrounding area. Packers Falls Dam was not overtopped during this high runoff, but according to the operator, the dam did appear to be in danger of overtopping.

5.4 Test Flood Analysis

Guidelines for establishing a recommended Test Flood based on the size and hazard classification of a dam are specified in the "Recommended Guidelines" of the Corps of Engineers. The impoundment of 500 acre-feet and the height of less than 40 feet classify this dam as a SMALL structure.

The appropriate hazard classification for this dam is SIGNIFICANT because of the potential for loss of a few lives at two houses and related economic

losses. As shown in Table 3 of the "Recommended Guidelines," the appropriate Test Flood for a dam classified as SMALL in size with a SIGNIFICANT hazard potential would be between the 100 year flood and half the Probable Maximum Flood (PMF). Since the risk downstream in the event of failure is on the low side of SIGNIFICANT, the appropriate Test Flood is the 100-year event.

Using the Log-Pearson Type III analysis of the stream gauge records downstream, the 100 year flood (.01 annual exceedance probability) is 7,055 cfs. This is 6.5 feet above the main spillway crest and 1.7 feet above the left abutment. The spillway capacity of 4,650 cfs with the water surface at the dam crest is 67 percent of the peak test flood outflow of 7,055 cfs.

5.5 Dam Failure Analysis

The peak outflow at Packers Falls Dam that would result from dam failure is estimated using the procedure suggested in the "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs." Failure is assumed to occur with the pool level at the top of the left abutment, 4.8 feet above the spillway crest. This is 17.8 feet above the natural streambed level. Just prior to failure, the normal outflow through the spillway would be 4,650 cfs. Assuming a 55 foot gap is opened in the dam, the peak failure outflow through this gap and over the remainder of the spillway would be 9,890 cfs.

Four houses are located in the reach extending from the dam to the Packers Falls bridge about 3,200 feet downstream. The first house is greater than 20 feet above the streambed and is about 800 feet downstream of the dam on the left bank. Two more houses, 15 and 20 feet above the streambed, are located about 2,200 feet downstream of the dam. The last house, on the left bank, is about 12 feet above the streambed at the stream gauging site discussed in Section 5.3.

Within this reach only two houses will be affected by flooding. The house located 2,200 feet downstream and 15 feet above the channel bottom, is above the prefailure flow stage of 11.8 feet. The failure flow of 9,890 cfs creates a stage of 16.6 feet and will probably cause damage to this house.

The second house to be affected by flooding is located at the gauging site 3,000 feet downstream of the dam. The prefailure stage of 11.8 feet may cause some minor damage, but the 16.6 foot stage created by the failure flood will certainly damage the structure and the possibility of loss of life exists.

The failure flow then enters the Packers Falls section of the Lamprey River, at the end of which is Packer Falls bridge. The rating table for this bridge indicates that the failure flow will only create a stage of about 8.5 feet, so the bridge will probably not be overtopped. The structure is in relatively good condition, so no damage is expected here.

Downstream of the bridge, no serious damage is expected from the failure flow. Housing in the area is well above the failure flow stages, and the wide and swampy overbanks provide ample storage for attenuation.

Because of this potential for loss of a few lives at two houses and related economic losses, the hazard classification for Packers Falls Dam is SIGNIFICANT.

Section 6: Structural Stability

6.1 Evaluation of Structural Stability

(a) Visual Observations

The Packers Falls dam is in FAIR condition at the present time. Considerable spalling of concrete was noted in the right end wall, the spillway, the gate structure, and the abandoned mill race gate structure. The right corewall has failed The left sluice gate operating mechanism is out of alignment.

(b) Design and Construction Records

No plans or calculations of value to a stability assessment are available for this dam.

6.2 Design and Construction Data

No records of structural stability analyses are available for this dam.

6.3 Post Construction Changes

The dam was constructed in 1911. The dam was repaired in 1967 including the installation of two new metal sluice gates and bench stands.

6.4 Seismic Stability

The dam is located in seismic zone No. 2, and, in accordance with the recommended Phase I guidelines, does not warrant seismic analysis.

Section 7: Assessment, Recommendations and Remedial Measures

7.1 Dam Assessment

(a) Condition

The Packers Falls Dam is in FAIR condition at the present time.

(b) Adequacy of Information

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgement.

(c) Urgency

The Engineering studies and improvement described herein should be implemented by the owner within one year of receipt of this Phase 1 Inspection Report.

7.2 Recommendations

It is recommended that the services of a qualified registered professional engineer be retained to :

(a) Conduct a detailed hydraulic and hydrologic study to further define the need for and means to increase the project discharge capacity and the ability of the dam to withstand overtopping

(b) Evaluate the need and make recommendations for the redesign or replacement of the right corewall.

(c) Inspect the spillway under low flow conditions and evaluate the effect on the structural stability if flashboards were used.

(d) Develop a method to remove all trees from the embankments, including the roots, and backfill the resulting voids with suitable compacted material.

(e) Evaluate the misaligned steel sluice gates and make recommendations for repair.

(f) Evaluate the condition of the abandoned mill race and make recommendations for appropriate treatment.

The owner should implement the findings of the above engineering studies.

7.3 Remedial Measures

It is recommended that the following remedial measures be undertaken by the owner:

(a) Remove all brush from the embankments.

(b) Implement a program of annual technical inspections of the dam and its appurtenances including operation of all functional outlet works.

(c) Develop a plan for surveillance of the dam during flood periods and a formal written downstream emergency warning system for warning downstream residents and officials.

(d) Implement and intensify a program of diligent and periodic maintenance.

7.4 Alternatives

There are no meaningful alternatives to the above recommendations.

APPENDIX A

VISUAL INSPECTION CHECKLIST

Inspection Team Organization

DATE: November 4, 1980

PROJECT: NH00441
Packers Falls Dam
Durham, New Hampshire
NHWRB 71.04

WEATHER: Clear, warm

INSPECTION TEAM:

Nicholas A. Campagna	Goldberg-Zoino & Assoc.	Team Captain
William S. Zoino	GZA	Soils
Jeffrey M. Hardin	GZA	Soils
Andrew Christo	Andrew Christo Engineers	Structures
Paul Razgha	ACE	Structures
Carl Razgha	ACE	Structures
Brian Chevalier	Resource Analysis, Inc.	Hydrology
Richard Laramie	RAI	Hydrology

NHWRB Representative Present - Richard Debold

NOTE: Brian Chevalier and Richard Laramie of Resource Analysis Inc., performed the hydrologic inspection of this dam on October 24, 1980 Paul Razgha and Carl Razgha of Andrew Christo Engineers, performed the structural inspection of this dam on November 13, 1980.

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
DAM EMBANKMENT		
Crest Elevation	JMH	60.5 feet (NGVD)
Current Pool Elevation		Approximately 56.0 feet (NGVD)
Maximum Impoundment to Date		Unknown
Surface Cracks		None noted
Pavement Conditions		Not applicable
Movement or Settlement of Crest		None noted
Lateral Movement		None noted
Vertical Alignment		Good
Horizontal Alignment		Good
Condition at Abutment and at Concrete Structures		Good
Indications of Movement of Structural Items on Slopes		Corewall in right embankment has been subjected to partial failure
Trespassing on Slopes		None noted
Vegetation on Slopes		Much brush and small trees growing on both left and right embankments
Sloughing or Erosion of Slopes or Abutments		None noted
Rock Slope Protection - Riprap Failures		None
Unusual Movement or Cracking at or near Toes	JMH	None noted

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
Unusual Embankment or Downstream Seepage	JMH	None noted with exception of abandoned sluiceway discussed at that item
Piping or Boils		None noted
Foundation Drainage Features		None
Toe Drains		None
Instrumentation System	JMH	None
LEFT EMBANKMENT CORE WALL		
Condition of Concrete	AC	Good, some minor surface cracks
Rusting or Staining		None noted
Spalling		None noted
Visible Reinforcing		None noted
Seepage		None noted
Efflorescence		None noted
RIGHT EMBANKMENT CORE WALL		
Condition of Concrete		Partially failed, central section leaning downstream, approximately 6 inch displacement
Rusting or Staining		None noted
Spalling		None noted
Visible Reinforcing		None noted
Seepage		None noted
Efflorescence	AC	None noted

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS		
a. Approach Channel	JMH	
General Condition		Gord
Loose Rock Overhanging Channel		None
Trees Overhanging Channel		Some overhanging trees up to 12 inch diameter. Not significant
Floor of Approach Channel	JMH	Submerged
b. Right End Wall		
Condition of Concrete	AC	Poor
Erosion		Up to 12 inches of erosion at interface with spillway
Spalling		75% of subsurface area spalled
Cracking		Non-spalled surfaces subjected to high degree of random cracking
Rusting or Staining of Concrete		None noted
Visible Reinforcing		None noted
Efflorescence		None noted
Seepage		None noted
c. Spillway Weir		
Condition of Concrete		Fair
Erosion - Spalling	AC	Pneumatic mortar on downstream face heavily eroded

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
Cracking	AC	Two continuous horizontal construction joints spalled
Rusting or Staining of Concrete		None noted
Visible Reinforcing		None noted
Efflorescence		None noted
Seepage		None noted
d. Left End Wall		
Condition of Concrete		Good
Erosion		None noted
Spalling		None noted
Cracking		Minor
Rusting or Staining of Concrete		None noted
Visible Reinforcing		None noted
Efflorescence		None noted
Seepage	AC	None noted
e. Discharge Channel		
General Condition	JMH	Good
Loose Rock Overhanging Channel		None
Trees Overhanging Channel		Minor
Floor of Channel		Submerged
Other Obstructions	JMH	Some minor debris

CHECKLIST FOR VISUAL INSPECTION

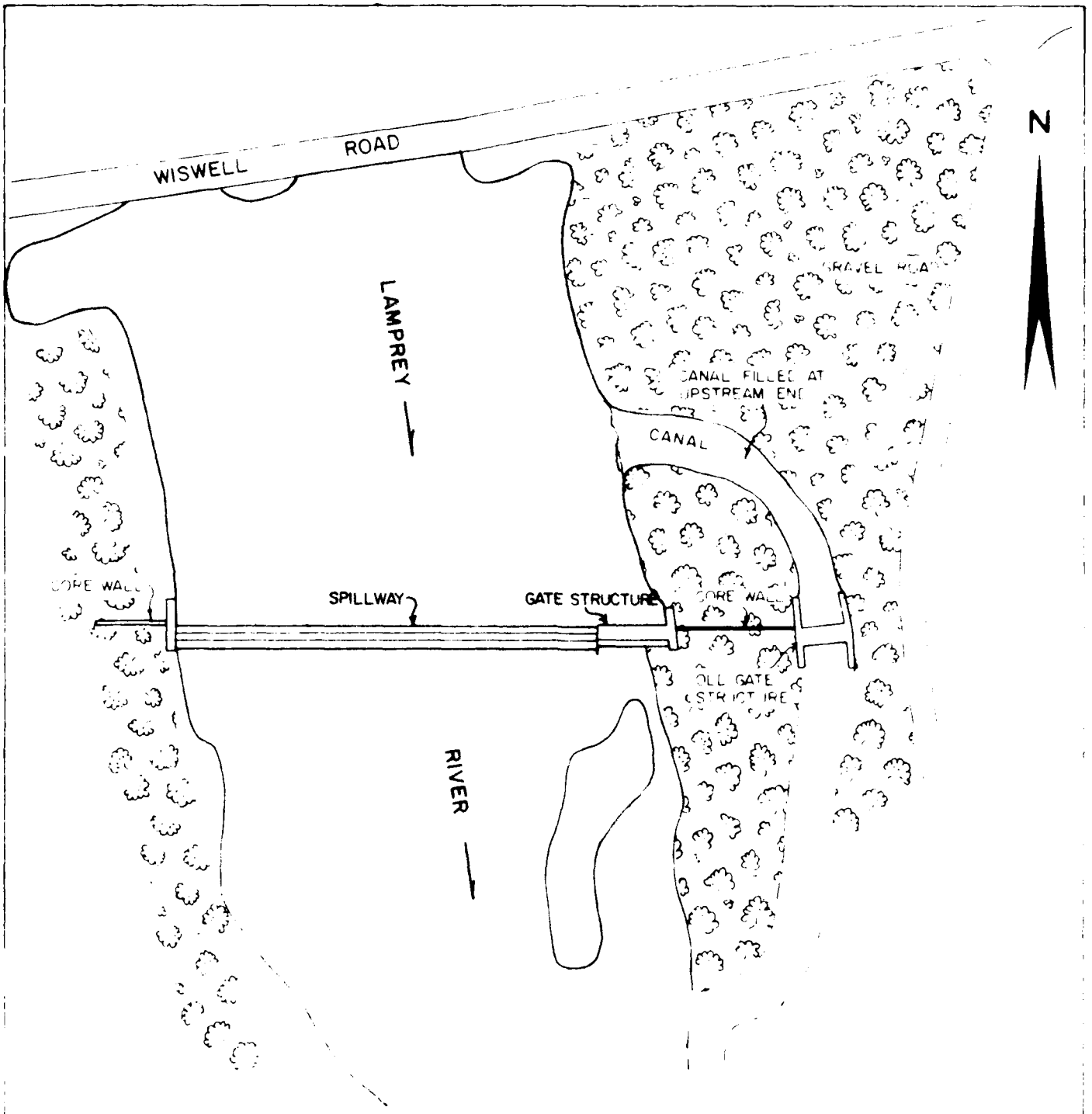
AREA EVALUATED	BY	CONDITIONS AND REMARKS
OUTLET WORKS - OUTLET STRUCTURE		
a. Gate Structure		
Condition of Concrete	AC	Poor
Erosion		None noted
Spalling		Extensive on upstream face and downstream intermediate buttress
Cracking		Extensive cracking over finished surface of pneumatically applied mortar
Rusting or Staining of Concrete		None noted
Visible Reinforcing		None noted
Efflorescence		Extensive over non-spalled concrete surfaces. High degrees of stalactite concentration on roof of outlet tunnels
Seepage		None noted
Sluice Gates	AC	Left bench stand tilted downstream, gate not seated. Continuous flow around gate. Right gate seated and in good condition

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
b. Mill Race Gate Structure		
Condition of Concrete	AC	Poor
Erosion		None noted
Spalling		Heavy on upstream and downstream faces
Cracking		Considerable random cracking
Rusting or Staining of Concrete		At exposed reinforcing steel
Efflorescence		At random cracking
Visible Reinforcing		Extensive on upstream and downstream faces
Efflorescence		Considerable on upstream and downstream faces.
Sluice Gates		Gates buried, stems and operating mechanisms removed. Forebay entrance filled with earth
Seepage	AC	Minor

APPENDIX B

ENGINEERING DATA



GOLDBERG ZOINO & ASSOCIATES, INC
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

SITE PLAN

PACKERS FALLS DAM

DURHAM, NEW HAMPSHIRE

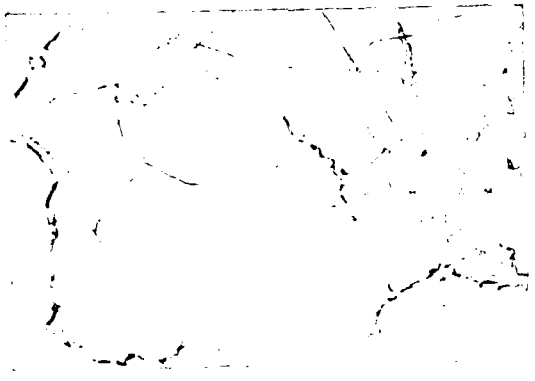
SCALE 1"=40'

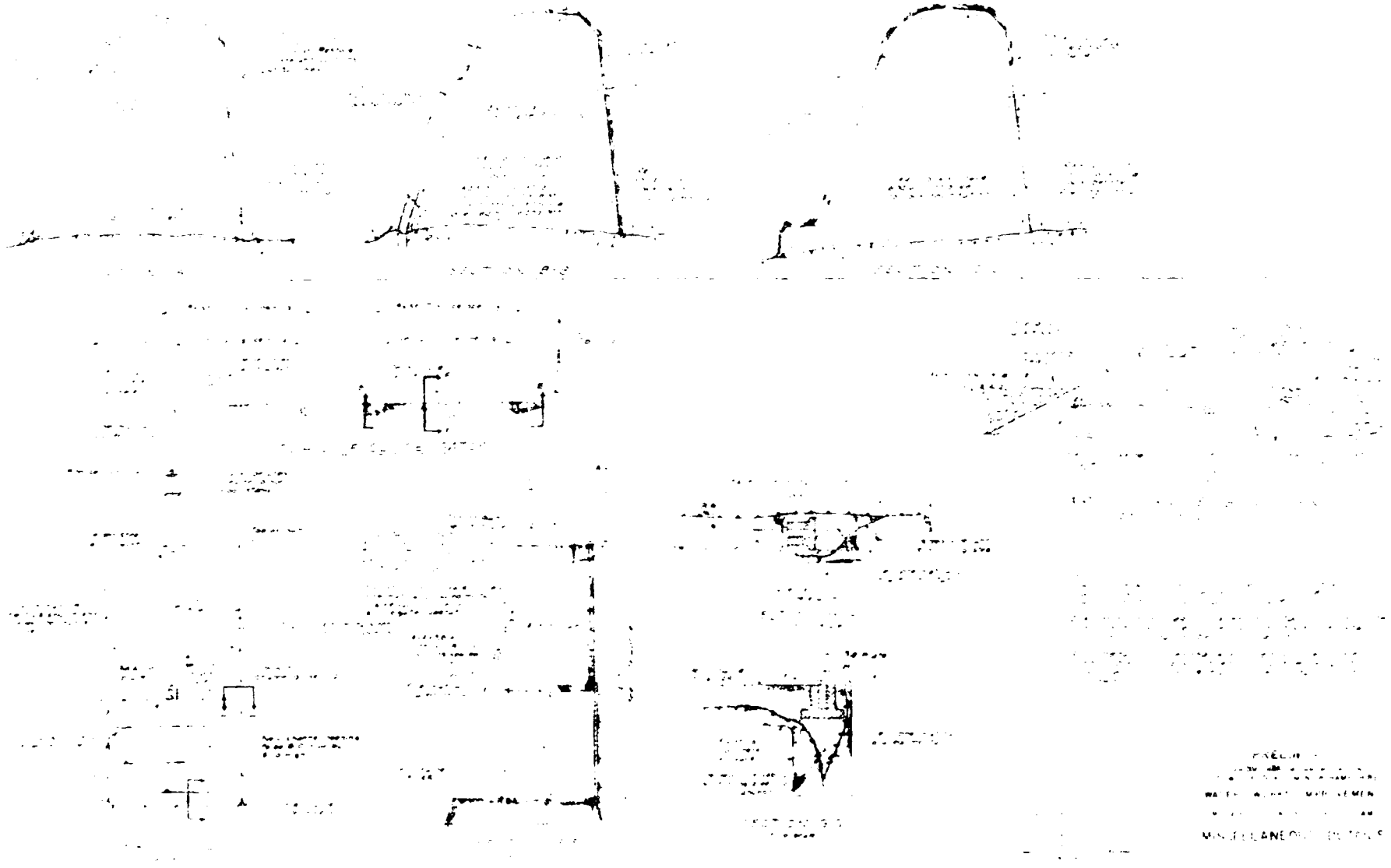
DATE NOV 1980

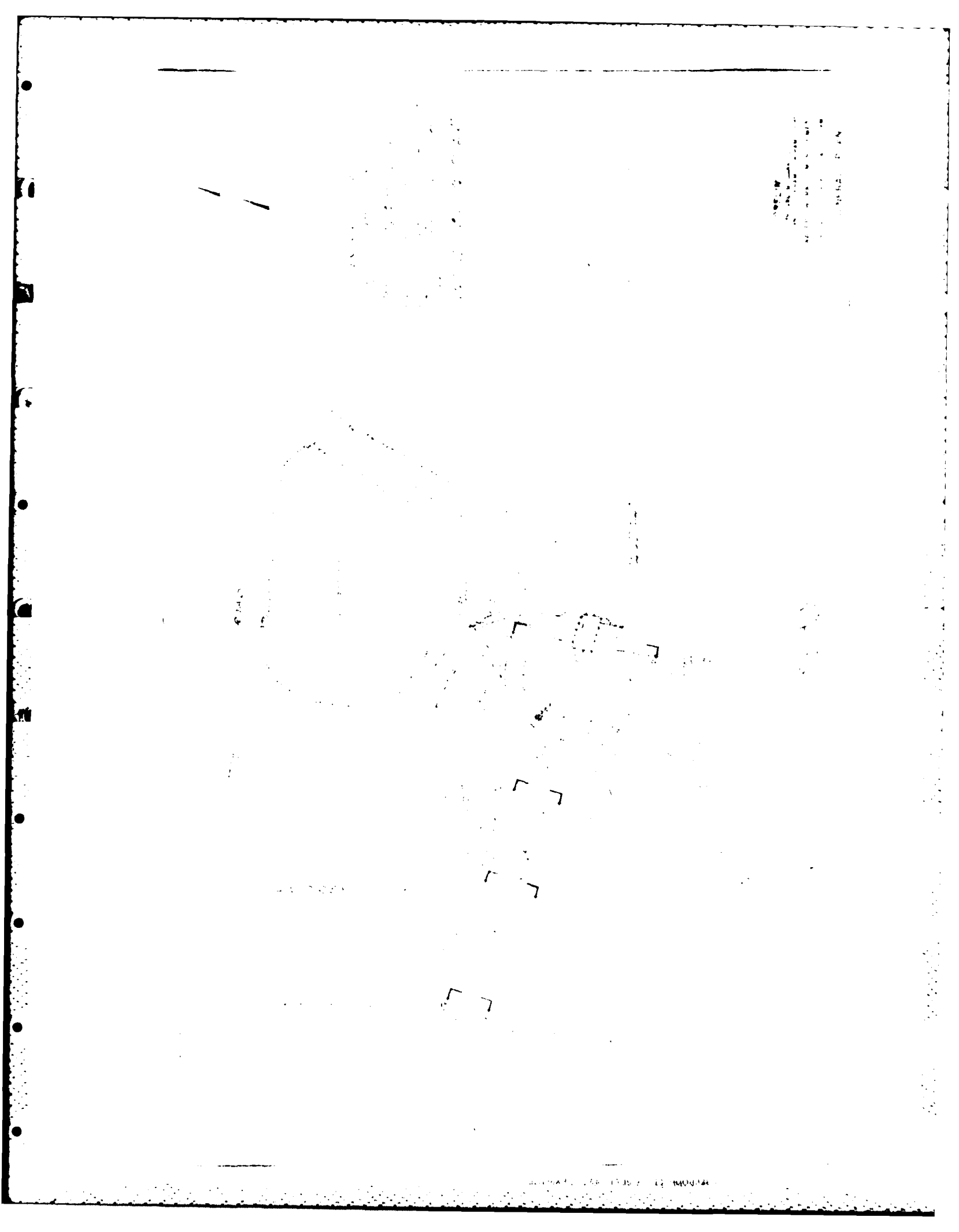
TOWN OF DURHAM, NEW HAMPSHIRE

WATER WORKS IMPROVEMENTS

REPLACING THE PACKERS FALLS DAM







THE STATE OF NEW HAMPSHIRE

County of Strafford ss. March 28, 19 66.

STATEMENT OF INTENT TO CONSTRUCT OR

RECONSTRUCT A DAM AT Durham, N H.

TO THE WATER RESOURCES BOARD:

APR 19 1966

NEW HAMPSHIRE
WATER RESOURCES BOARD

In compliance with the provisions of RSA 482:3.

We,
The Board of Selectmen, Durham, New Hampshire
(Here state name of person or persons, partnership, association, corporation, etc.)

hereby state our intent to the Water Resources Board to ~~construct, reconstruct,~~ to make repairs to, a dam ~~xxxxx~~ or (cross out portion not applicable) across:

The Lamprey River
(Here state name of stream or body of water)

At a point near Wiswell Road, Durham, New Hampshire, approximately 2.6 miles north and west of the Strafford-Rockingham county line
(Here give location, by distance from mouth of stream, county or municipal boundary)

in the town (s) of Durham, New Hampshire

in accordance with PRELIMINARY PLANS, and SPECIFICATIONS FILED WITH THIS STATEMENT AND MADE A PART HEREOF.

We, understand that more detailed plans and specifications may be requested by the Board in conformance with RSA 482:4 and that, if such plans are requested, construction will not commence until such plans have been filed with and approved by the Board.

The purpose of the proposed construction is to restore the existing dam and sluice gates. The impounded water is to be used as an additional water supply for the Town of Durham and the University of New Hampshire

(Here briefly state use to which stored water is to be put)

The construction will consist of restoring the existing concrete surfaces with pneumatically applied mortar, installing new sluice gates and the filling of the existing canal.

(Here give brief description of work contemplated including height of dam)

All land to be flowed ~~is~~ not ~~xx~~ owned by applicant.

* See note below

Board of Selectmen

Henry A. Davis

Donald M. Swinerton

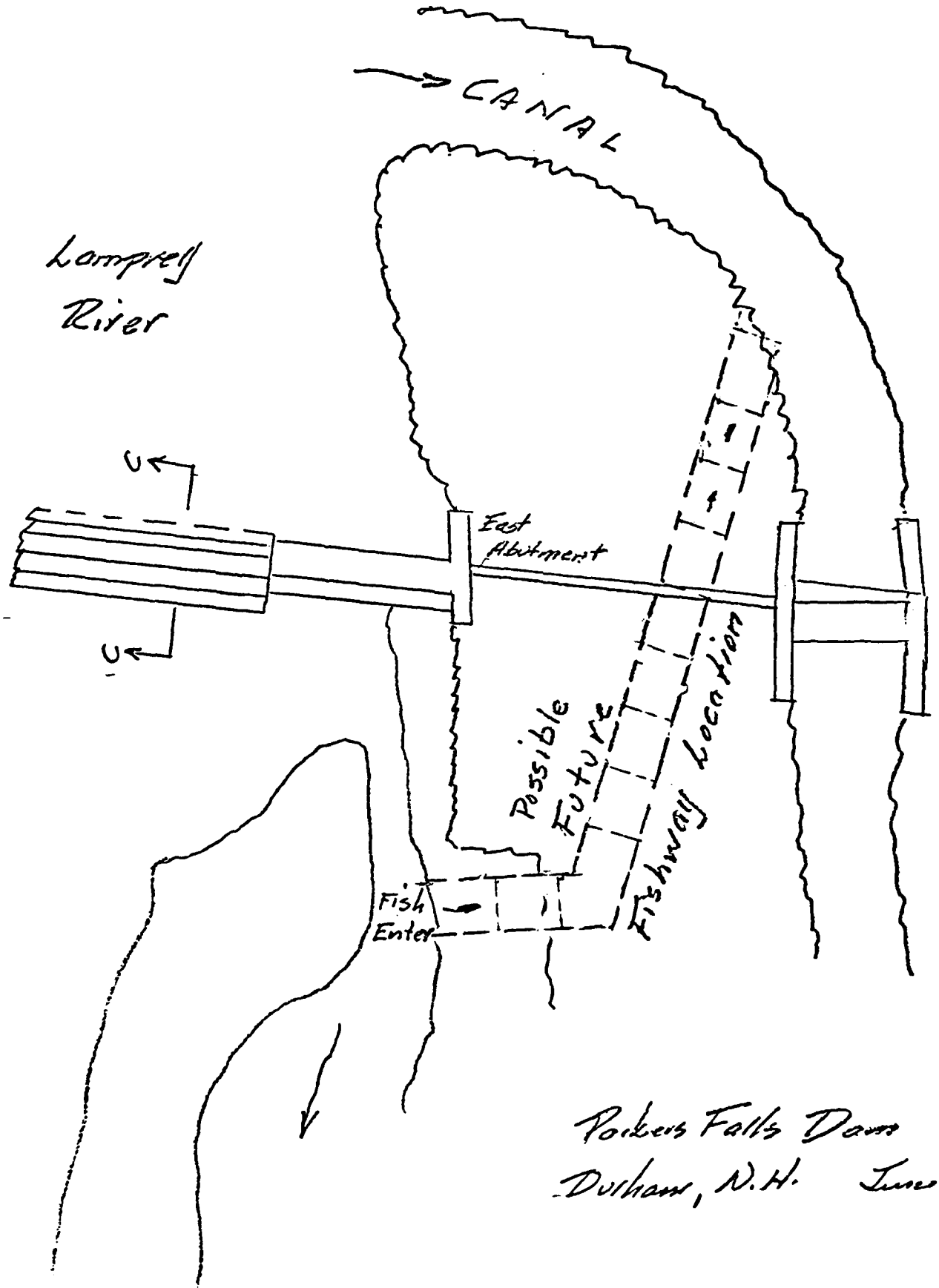
James Wilson Durham

Address Town Hall

Durham, New Hampshire

Note: This statement together with plans, specifications and information and data filed in connection herewith will remain on file in the office of the Water Resources Board. This statement is to be filed in duplicate.

Note: No change in elevation of the existing dam is proposed.


CANAL
N
Lamprey River
U
U
East Abutment
Possible Future Fishway Location
Fish Enter
Packers Falls Dam
Durham, N.H. June 1966

April 26, 1966

Mr. William E. Mackey, Jr.
Camp, Dresser & McKee
18 Tremont Street
Boston, Massachusetts 02108

Dear Mr. Mackey:

One copy of the plans you submitted on the Eckers Falls Dam has been forwarded to the New Hampshire Fish and Game Department.

They have indicated that they would like a cold water pipe included in the dam so that sufficient flow is assured to maintain fish life at all times.

Also, they mentioned the possibility of a fish ladder. I suggest that you contact them directly to work out these points. The individual to contact is: Allen I. Lewis, Fish and Game Engineer, N.H. Fish and Game Department, 34 Bridge Street, Concord, New Hampshire 03301.

The Water Resources Board will temporarily withhold approval pending the outcome of the Fish and Game requests.

If you have any questions, please contact us.

Very truly yours,

Wayne E. Kibby
Civil Engineer

wek:c

Mr. Smith, Pub.Serv.Co. of N.H. phoned at 2:00 - Sept. 15, 1960

Newmarket Company sold the Packer's Falls to the Lamprey River Improvement Company who in turn sold it to the New Hampshire Gas and Electric Company, now the New Hampshire Electric Company. Sold it on December 28, 1945, recorded in Book 1043, Page 17.

On October 10, 1955 New Hampshire Electric Company conveyed to the Macallen Company in Newmarket various pieces of land and also conveyed as follows: Such rights and interests in that portion of the Lamprey River extending northerly from said dam in Newmarket to Packer's Falls, so-called, in Durham, together with such other rights and privileges in the Piscassic River, Sheppard's Brook, Oyster River, Doe's Moat in the Towns of Durham and Newmarket, including rights of flowage, drainage, dyking privileges and such other rights as were originally acquired by the New Hampshire Gas and Electric Company, now New Hampshire Electric Company, by deed of the Lamprey River Improvement Company dated December 28, 1945. Such rights and interests as herein conveyed are limited strictly to the areas herein specified and do not include any similar rights and interests in the Towns of Barrington and Lee or in the Town of Nottingham.

Deed read from is recorded but Mr. Smith just had a copy of it so does not know the book number or page. Could be looked up in the Rockingham County Registry of Deeds.

Mr. Smith believes it includes Packer's Falls as it says: to Packer's Falls. They sold some land that they owned around Packer's falls. Mr. Smith tried to contact Manager of the New Hampshire Electric Company. Mr. Smith said that to the best of his knowledge the Packer's Falls had been conveyed.

September 15, 1960

Mr. Roland S. Burlingame
Camp, Dresser and McKee
18 Tremont Street
Boston 8, Massachusetts

Dear Roland:

I am enclosing copies of a map and a plan which we have in our files on the Packer's Falls project on the Lamprey River. Francis has also examined the Public Utilities docket and pulled out some comments which I am enclosing.

I think the dam that is referred to as "present pond" in this docket information is not existing at this time.

If there is any interest on your part, I think there is more information that could be worked up on this project from other sources.

Very truly yours,

Leonard R. Frost
Water Resources Engineer

lrf:c
encls.

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN Durham DAM NO. 71.04 STREAM Lamprey River

OWNER Lamprey River Imp. Co. ADDRESS Newmarket, N.H.

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on 18 May 1950 ~~accompanied by~~

NOTES ON PHYSICAL CONDITION

Abutments Good

Spillway Fair

Gates Poor - need new lumber for gates & gatestems.

Other Canal filled with debris - no head

CHANGES SINCE LAST INSPECTION Deteriorated, especially gates

FUTURE INSPECTIONS Yes

This dam (is) ~~is not~~ a menace because of lack of bracing.

REMARKS Gates need new lumber badly

Copy to Owner	Date

Francis C Lyons
INSPECTOR

(Additional Notes Over)

IN E2 8252

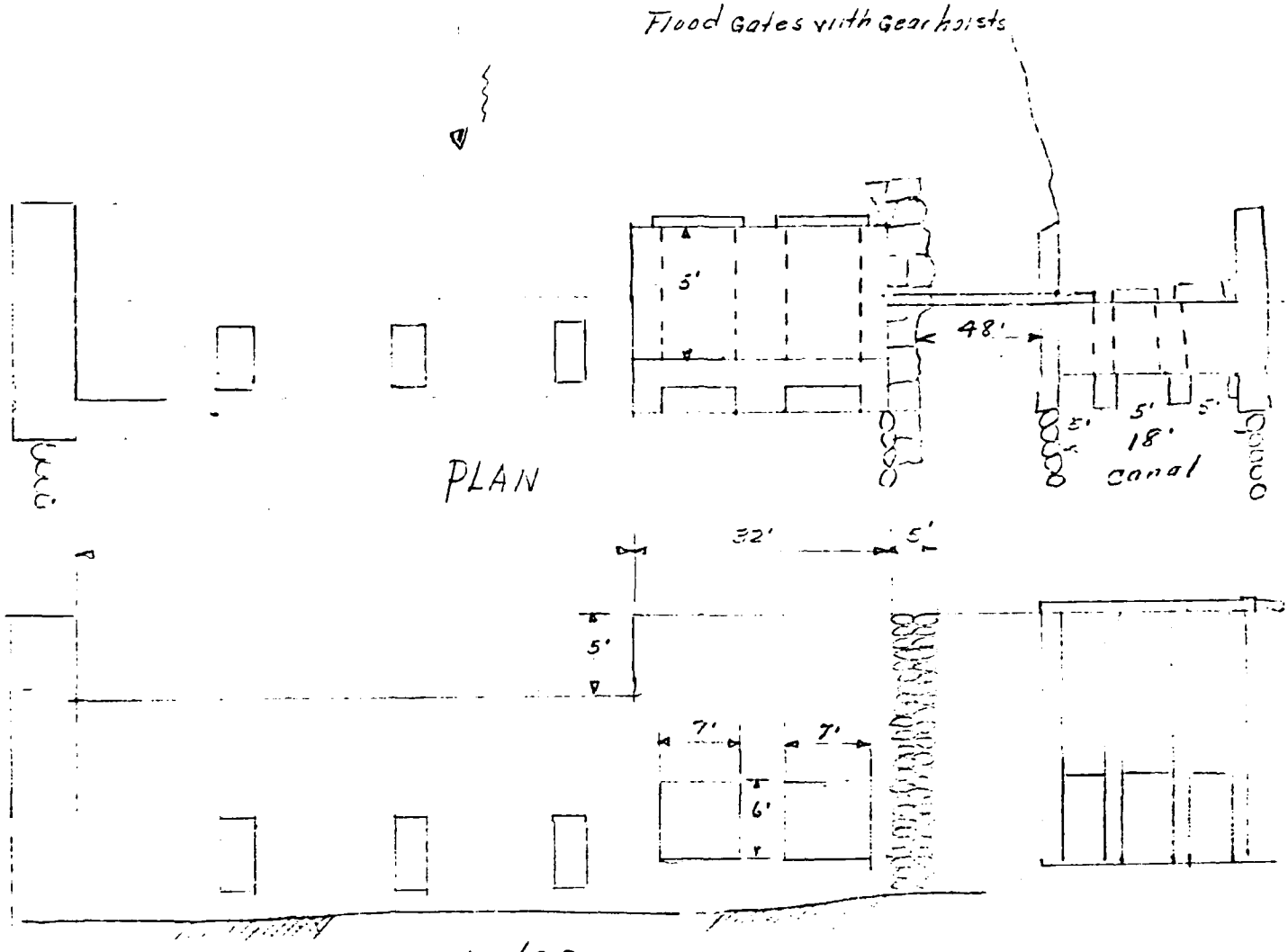
NEW HAMPSHIRE
WATER RESOURCES
BOARD
CONCORD, N. H.

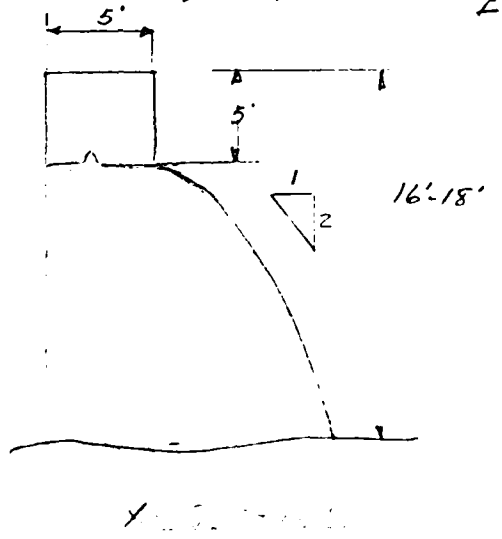
PROJECT PACKERS FALLS FILE 71.04

SUBJECT LAMPREY RIVER DURHAM ACC.

OCEAN. LAMPREY R. LAMPREY Rive. IMP. Co Newmarket N.H

COMPUTER G.S.N. CHECKER P.L.T CONT. FROM ACC. CONT. ON ACC. SUMMARY ON ACC. DATE 10/11/39





7204

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 71.04

Town Durham: County Strafford

Stream Lamprey River

Basin-Primary Ocean: Secondary Lamprey R

Local Name Packers Falls

Coordinates—Lat. 43° 5'+7400 7600: Long. 70° 00' -9800 71° 00' 9800

GENERAL DATA

Drainage area: Controlled 183.02 Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 183 Sq. Mi.

Overall length of dam 110 ft.: Date of Construction 1

Height: Stream bed to highest elev. 18 ft.: Max. Structure 13 ft.

Cost—Dam 12' (11/78): Reservoir .....

DESCRIPTION Gravity Concrete Ledge Foundation

Waste Gates

Type .....

Number 2: Size 6 ft. high x 7 ft. wide

Elevation Invert 16': Total Area 2-42' (84) sq. ft.

Hoist .....

Waste Gates Conduit

Number .....: Materials .....

Size ..... ft.: Length ..... ft.: Area ..... sq. ft.

Embankment

Type .....

Height—Max. ..... ft.: Min. ..... ft.

Top—Width .....: Elev. ..... ft.

Slopes—Upstream ..... on .....: Downstream ..... on .....

Length—Right of Spillway .....: Left of Spillway .....

Spillway

Materials of Construction Concrete

Length—Total ..... ft.: Net 65 ft.

Height of permanent section—max. 13 ft.: Min. ..... ft.

Flashboards—Type .....: Height ..... ft.

Elevation—Permanent Crest .....: Top of Flashboard .....

Flood Capacity 4100 cfs.: ..... cfs/sq. mi.

Abutments

Materials: .....

Freeboard: Max. 5' ft.: Min. ..... ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Lamprey River Imp Co Newmarket N H

REMARKS Use- Power- Conservation

Tabulation By C D C Date September 13, 1938.

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD

I-4535

TOWN	Durham	TOWN NO. 4	STATE NO. 7104
RIVER STREAM	Lamprey River		
DRAINAGE AREA	183.2	POND AREA	
DAM TYPE	Gravity	FOUNDATION NATURE OF	Ledge
MATERIALS OF CONSTRUCTION	Concrete		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTION—PUBLIC UTILITY		
HEIGHTS TOP OF DAM TO BED OF STREAM	18' 1a' (11/78)	TOP OF DAM TO SPILLWAY CRESTS	5'
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	Approx.	LENGTH OF DAM	Approx.
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	None		
OPERATING HEAD CREST TO N. T. W.	10'-12'	TOP OF FLASHBOARDS TO N. T. W.	
WHEELS, NUMBER KINDS & H. P.			
GENERATORS, NUMBER KINDS & K. W.			
H. P. 90 P. C. TIME 100 P. C. EFF.		H. P. 75 P. C. TIME 100 P. C. EFF.	
REFERENCES, CASES, PLANS, INSPECTIONS.			
REMARKS			

OWNER- Lamprey River Imp. Co.

CONDITION- Fair

MENACE- Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made August 1, 1935, and bill for same is enclosed.

Samuel J. Lord
Hyd. Eng.

Sept. 13, 1935
Copy to Owner

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Ocean NO. 4 — 46 — I-4535
RIVER Lamprey MILES FROM MOUTH ____ D.A.SQ.MI. 183 WRB
TOWN Durham OWNER Lamprey River Hydro-Elec. Co., Newmarket
LOCAL NAME OF DAM Packers Falls
BUILT ____ DESCRIPTION Gravity — Concrete on Ledge

POND AREA-ACRES ____ DRAWDOWN FT. ____ POND CAPACITY-ACRE FT. ____
HEIGHT-TOP TO BED OF STREAM-FT. 18 MAX. ____ MIN. ____
OVERALL LENGTH OF DAM-FT. 110 ± MAX.FLOOD HEIGHT ABOVE CREST-FT. ____
PERMANENT CREST ELEV.U.S.G.S. ____ LOCAL GAGE ____
TAILWATER ELEV.U.S.G.S. ____ LOCAL GAGE ____
SPILLWAY LENGTHS-FT. 65 ± (71 WRB) FREEBOARD-FT. ~ (4.0 WRB)
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST None

WASTE GATES-NO.	WIDTH	MAX. OPENING	DEPTH SILL BELOW CREST
2	7	6	16

REMARKS Condition Fair.

EI

Assumed C = 3.0

POWER DEVELOPMENT

UNITS	NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE
			10-12			

USE Power & Conservation

REMARKS

DATE 8/1/35

7206

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 71.04

Town Durham : County Strafford

Stream Lamprey River

Basin-Primary Ocean : Secondary Lamprey R

Local Name

GENERAL DATA

Head-Max. 12 ft.: Min 10 ft.: Ave. 11 ft.

Date of Construction : Use of Power Power & Conservation

Pondage ac. ft.: Storage ac. ft.

DESCRIPTION

Racks

Size of Rack Opening

Size of Bar : Material

Area: Gross Sq. Ft.: Net sq. ft.

Head Gates

Type

Number : Size ft. high x ft. wide

Elevation of Invert : Total Area sq. ft.

Hoist

Penstock

Number : Material

Size : Length

Turbines

Number Ruins : Makers

Rating HP. per unit : Total Capacity HP.

Max. Dement C.F.S., per unit : Total cfs.

Drive

Type

Generator

Number

Make

Rating KW., per unit ; Total Capacity K. W.

Exciter

Number : Make

Rating-per unit : Total Capacity K. W.

OUTPUT—KWHRS

19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	

OWNER Lamprey River Imp Co Newmarket N H

Tabulation By A.A.N.&R.L.T Date November 28, 1938.

Docket D-550 N.H. Public Service Comm. July 22, 1919
Rockingham County Light and Power Company
Lamprey River - Durham, N. H.

Present Pond Level 56' - Area 82.0 Acres
Proposed Pond Level 74.5' Area 561.95 (479.95 additional)

18.5' rise

Dam originally built in 1911

6,000,000 KW ~~hrs~~ annual capacity

Estimate maximum flow has been 3,000 cfs.

Install 2 wheels with capacity of 550 cfs each.
Install 2 Tainter Gates with combined capacity of 7,000 to 8,000 cfs.
Can take care of 5,000 cfs. above average flow of river.

Will gain additional 15' head by canal.

Started getting water rights in August 1916

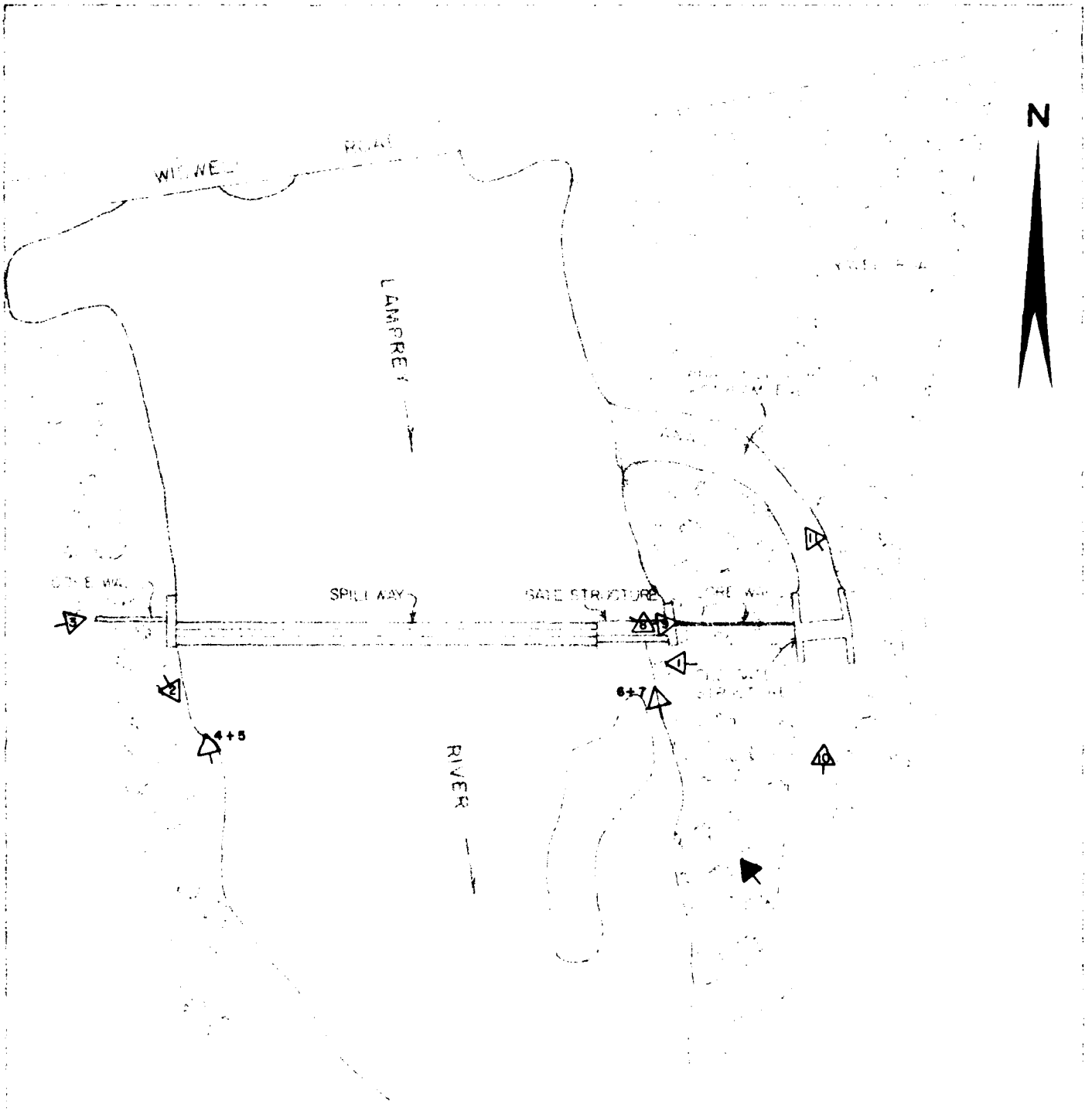
Drainage Area 190 square miles.

Use 1100 cfs - 40 to 50 days. (possibly as little as 10 days) / year

10 hrs on both wheels lowers pond 6" (no inflow)

APPENDIX C

PHOTOGRAPHS



OVERVIEW PHOTO

APPENDIX C PHOTO

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PHOTO LOCATION PLAN

DURHAM, NEW HAMPSHIRE

1. Principal Spillway - Note Buttresses on Downstream Face.

2. Downstream Channel from Right Abutment

3. Core Wall at Right Abutment - Note Horizontal Displacement and Cracking.

4. Right End Wall - Note Erosion at Water Level and Severe Spalling of Concrete.

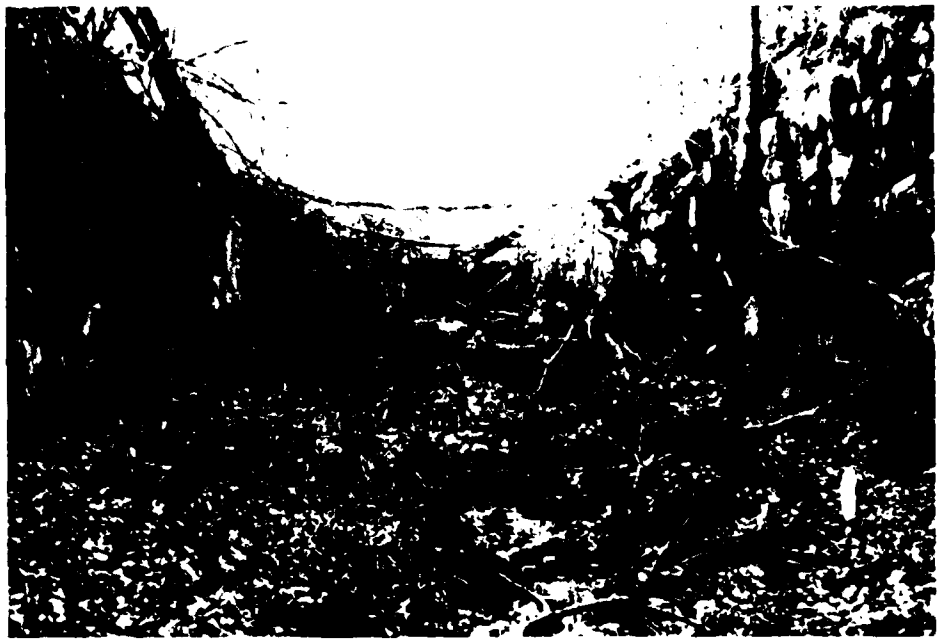
5. Detail of Erosion and Deterioration of Right End Wall.

6. Waste Gate Structure Near Left Abutment - Note Seepage Through Gates.

7. Detail of Gate Structure - Note Spalling of Gunite Coating.

8. Left End Wall - Note Minor Efflorescence.

9. Corewall at Embankment Section - Note Heavy Brush Growth.



10. Abandoned Sluiceway at Left Abutment - Note Gates at Far End and Slight Seepage Flow.

11. Abandoned Sluiceway Upstream of Gates - Note Incomplete Backfill

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

Dam Failure Analysis

See schematic sketch of dam on next page.

Outflow at Failure = Outflow through breach and
Normal Outflow at Failure elevation of pool

Assume that the dam fails with the pool level at the top of the right abutment, which is :

4.8 feet above the main spillway and
12.5 feet above the bottom of the orifice gates.

Normal Outflow at Failure

Orifice gates: Assumed to be open at failure

1. Low Flow - use weir equation

   $c = 3.1 \quad L = 12$

   $Q_2 = (3.1)\ (12)\ (H)^{1.5}$

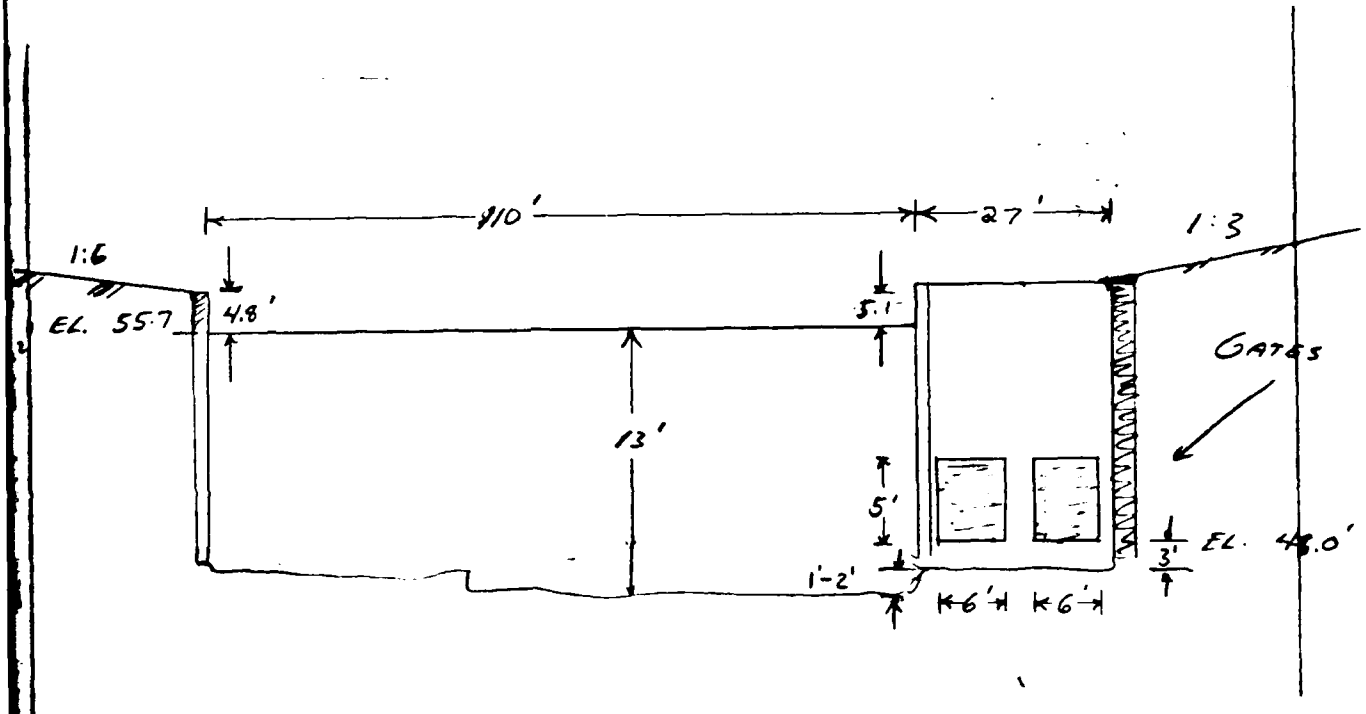
2. High Flow - use orifice equation and assume C_d approaches .611 for this structure

   $Q_2 = C_d(a\sqrt{2g\bar{h}})$

   $C_d = .611 \quad a = 60\ ft^2 \quad \bar{h} = HEAD-2.5'$

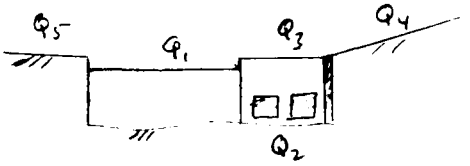
   $Q_2 = (.611)(60)(\sqrt{(2)(32.2)(H - 2.5)})$

SCHEMATIC DIAGRAM OF PACKERS FALLS DAM



Not to Scale

Main Spillway:



where:

$c = 3.1$

$L = 110'$

$Q_1 = (3.1)(110)\ (H - 7.7)^{1.5}$

Abutment Flow and Overbank Flow:

$$Q_3 = (3.0)(27)\ (H - 12.8)^{1.5}$$

$$Q_4 = (2.8)\ (H - 12.8)\ (3)\ (.5 * (H - 12.8))^{1.5}$$

$$Q_5 = (2.8)(6)\ (H - 12.5)\ (.5\ (H - 12.5))^{1.5}$$

The BASIC program shown on the next page computes the rating curve with the previous equations. A rating table for this structure is shown on the following page.

From the rating table, a failure elevation of 4.8 feet above the spillway crest (12.5 feet above orifice) would have 4650 cfs flowing over the structure.

Normal Outflow at Failure = 4650 cfs

Breach Outflow

$$Q_{p1} = (8/27)\ (W_b)(\sqrt{g})\ Y_o^{\frac{3}{2}}$$

W_b = Width of breach

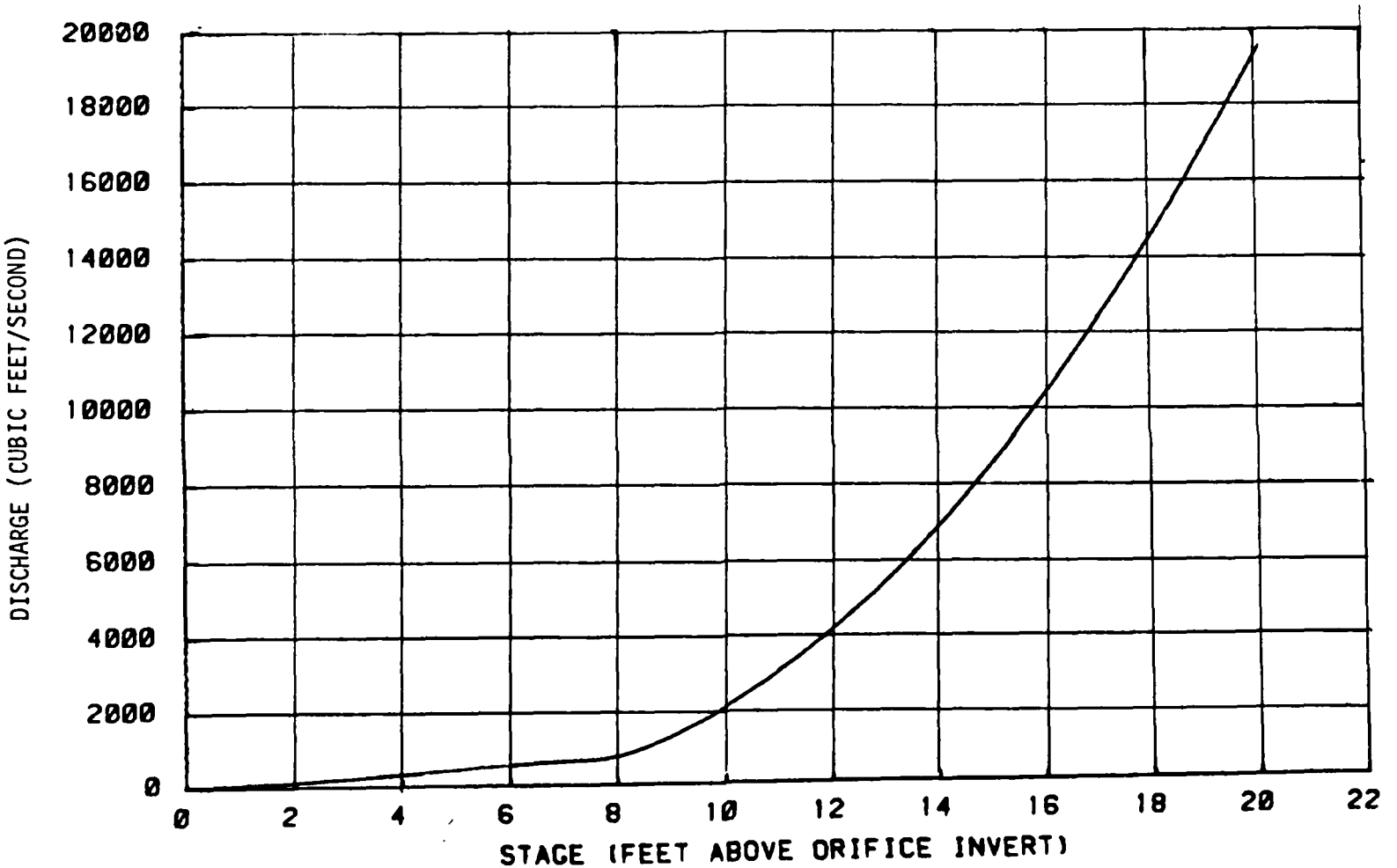
≈ 0.4 x (Width of dam at ½ height)

```
100 REM - STAGE/DISCHARGE CURVE FOR PACKARD FALLS DAM
110 REM - STORED ON TAPE B-1 FILE 20
120 PAGE
130 PRINT USING 140:
140 IMAGE 10T "STAGE VS. DISCHARGE RELATIONSHIP FOR PACKERS FALLS DAM"
150 PRINT USING 160:
160 IMAGE / 6T"HEAD"30T"DISCHARGE"
170 PRINT USING 180:
180 IMAGE 1T"(FT. ABOVE ORIFICE)"32T"(CFS)"
190 PRINT USING 200:
200 IMAGE 17T"TOTAL          SPILLWAY      GATES          ABUTMENTS"
210 PRINT " "
220 FOR H=0 TO 30 STEP 1
230 O1=0
240 O2=0
250 O3=0
260 O4=0
270 O5=0
280 O2=3.1*12*H↑1.5
290 IF H<=5 THEN 380
300 O2=0.611*60*(2*32.2*(H-2.5))↑0.5
310 IF H<=7.7 THEN 380
320 O1=3.2*110*(H-7.7)↑1.5
330 IF H<=12.5 THEN 380
340 O5=2.8*(H-12.5)*6*(0.5*(H-12.5))↑1.5
350 IF H<=12.8 THEN 380
360 O3=3*27*(H-12.8)↑1.5
370 O4=2.8*(H-12.8)*3*(0.5*(H-12.8))↑1.5
380 T2=O3+O4+O5
390 T1=O1+O2+T2
400 PRINT USING 410:H;T1;O1;O2;T2
410 IMAGE 6D.2D,12D,14D,14D,14D
420 NEXT H
430 END
```

STAGE VS. DISCHARGE RELATIONSHIP FOR PACKERS FALLS DAM

HEAD (FT. ABOVE ORIFICE)	DISCHARGE (CFS) TOTAL	SPILLWAY	GATES	ABUTMENTS
0.00	0	0	0	0
1.00	37	0	37	0
2.00	105	0	105	0
3.00	193	0	193	0
4.00	298	0	298	0
5.00	416	0	416	0
6.00	550	0	550	0
7.00	624	0	624	0
8.00	748	58	690	0
9.00	1272	522	750	0
10.00	2034	1228	806	0
11.00	2968	2110	858	0
12.00	4045	3139	907	0
13.00	5257	4295	953	8
14.00	6691	5566	998	128
15.00	8327	6943	1040	344
16.00	10152	8417	1081	654
17.00	12163	9983	1120	1060
18.00	14359	11636	1158	1565
19.00	16740	13371	1195	2175
20.00	19308	15184	1231	2893
21.00	22064	17073	1265	3725
22.00	25009	19035	1299	4675
23.00	28145	21066	1332	5747
24.00	31475	23165	1364	6947
25.00	35001	25329	1395	8277
26.00	38724	27556	1426	9742
27.00	42648	29845	1456	11346
28.00	46774	32195	1486	13093
29.00	51105	34603	1514	14987
30.00	55642	37068	1543	17031

STAGE-DISCHARGE CURVE FOR PACKERS FALLS DAM



Breach Outflow (cont.)

use $W_b = (.4)\ 137 = 54.8$

Y_o = pool elevation at failure

$= 13 + 4.8 = 17.8'$

$Q_{pi} = (8/27)\ (54.8)\ (\sqrt{32.2})\ \ (17.8)^{1.5}$

$Q_{pi} = \underline{6920}$ cfs

Total Outflow at Failure

Since the breach is assumed to occur at the main spillway section, 40% of the normal spillway outflow is included in the breach outflow calculation so,

Failure Flow = .6 (Normal Outflow) + Breach Outflow

= .6 (4650) + 6920 = $\underline{9710}$ cfs

Stage Storage Curve

The storage capacity of Packers Fall Dams at the spillway crest is 360 acre-ft. The storage capacity at the top of the left abutment, or 4.8 feet above the spillway crest is 500 acre-ft.

If h = height above spillway crest, then

Surcharge Storage = $\frac{500 - 360}{4.8}$ = 29.2 acre (h)

Total Storage = 360 + 29.2 (h)

For the drainage area of 183 square miles (117,120 acres):

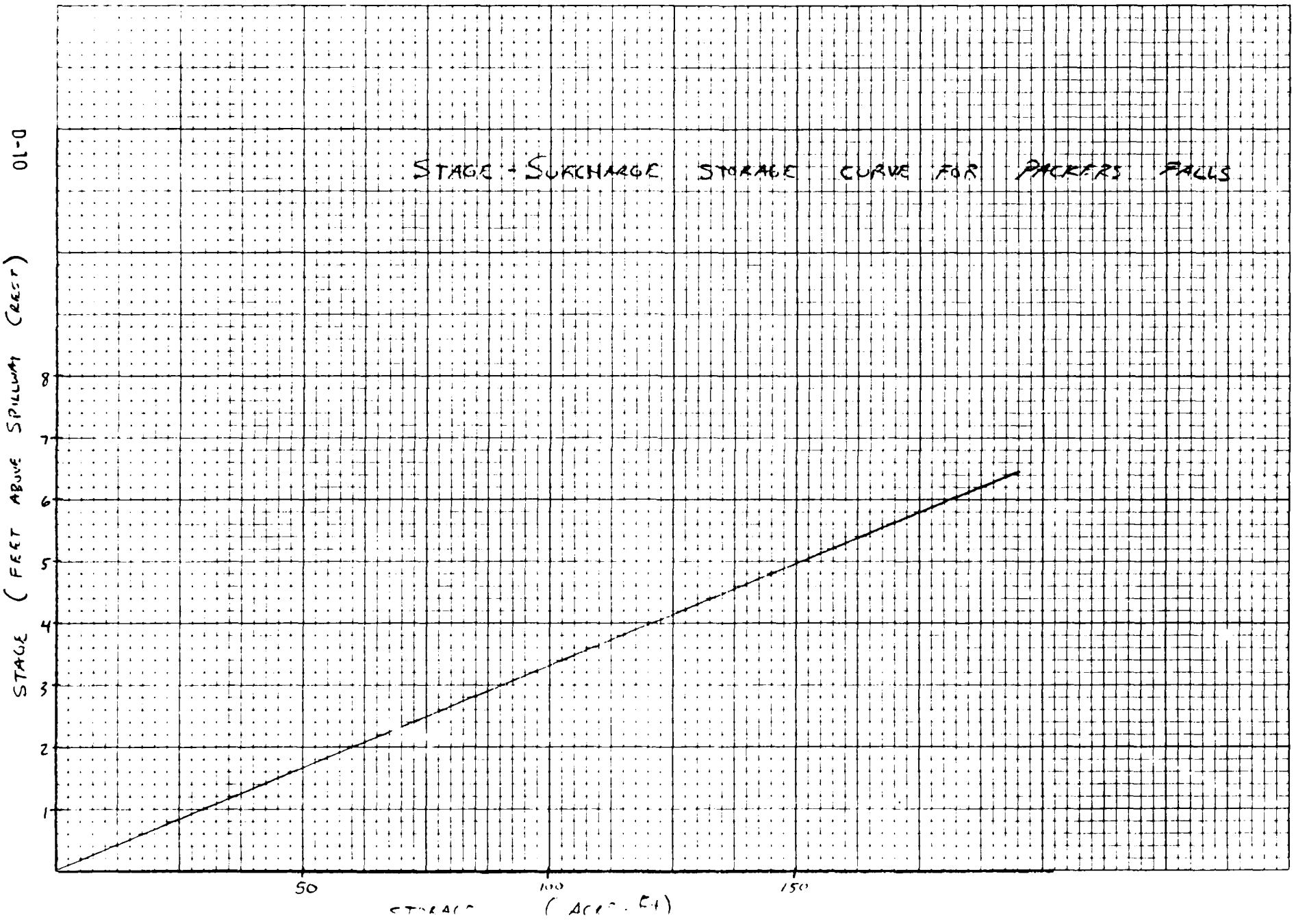
$$1\text{" of runoff} = \frac{117,120\ (1")}{(12"/ft)} = 9760 \text{ acre-ft.}$$

$$1 \text{ acre-ft.} = \frac{1}{9760} = 0.00102\text{" of runoff.}$$

Surcharge storage to the top of the left abutment:

$$4.8\ (29.2) = 140 \text{ acre-ft} = 0.14\text{" of runoff}$$

The stage-surcharge storage curve is shown on the next page.



Downstream Flooding

The next four pages show the rating table for a U.S.G.S. stream gauging site on the Lamprey River. This site is located about 3000' downstream of Packers Falls Dam. Following the rating table is shown the rating curve which is extended beyond the largest stage shown in the rating table.

From the rating curve a prefailure flow of 4650 (cfs) would create a stage of 11.8 feet. A failure flow of 9890 cfs would raise the stage to 16.6 feet above the streambed.

The attenuated affects in the reach between the dam and the Packers Falls Bridge are considered negligible due to the confining nature of the channel and the lack of storage in the steep overbanks.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE DATE PRINTED 08-03-78

01073500 LAMPREY RIVER NEAR NEWMARKET, NH

TYPE LOGISCALE OFFSET = 0.11) RATING NO 29

BASED ON _____ DISCHARGE MEASUREMENTS, NO._____, AND _____, AND IS _____ WELL DEFINED BETWEEN _____ AND _____

FROM _____ TO _____, FROM _____ TO _____ *COMP BY _____ DATE _____

*CKD. BY _____ DATE _____

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (STANDARD PRECISION)										DIFF IN Q PER TENTH GH
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
0.30	3.9	4.1	4.3	4.5	4.7	4.9	5.2	5.4	5.6	5.8	2.1
0.40	6.0	6.3	6.5	6.8	7.1	7.3	7.6	7.9	8.2	8.5	2.7
0.50	8.7	9.0	9.3	9.7	10	10	11	11	11	12	3
0.60	12	12	13	13	14	14	14	15	15	16	4
0.70	16	17	17	17	18	18	19	19	20	20	5
0.80	21	21	22	22	23	24	24	25	25	26	6
0.90	27	27	28	29	29	30	31	31	32	33	7
1.00	34	35	35	36	37	38	39	39	40	41	8
1.10	42	43	44	45	46	47	48	49	50	51	10
1.20	52	53	54	55	56	58	59	60	61	62	11
1.30	63	64	65	67	68	69	70	72	73	74	12
1.40	75	77	78	79	81	82	83	85	86	87	14
1.50	89	90	92	93	95	96	98	99	101	102	15
1.60	104	105	107	108	110	111	113	114	116	117	15
1.70	119	121	122	124	125	127	128	130	132	133	16
1.80	135	137	138	140	141	143	145	147	148	150	17
1.90	152	153	155	157	158	160	162	164	165	167	17
2.00	169	171	172	174	176	178	180	181	183	185	18
2.10	187	189	191	192	194	196	198	200	202	204	19
2.20	206	208	210	211	213	215	217	219	221	223	19
2.30	225	227	229	231	233	235	237	239	241	243	20
2.40	245	247	249	251	253	255	257	260	262	264	21
2.50	266	268	270	272	275	277	279	281	284	286	22
2.60	288	290	293	295	297	299	302	304	306	309	23
2.70	311	314	316	318	321	323	325	328	330	333	24
2.80	335	338	340	343	345	347	350	352	355	357	25
2.90	360	363	365	368	370	373	375	378	381	383	26
3.00	386	389	391	394	397	399	402	405	407	410	27
3.10	413	416	418	421	424	427	429	432	435	438	28
3.20	441	443	446	449	452	455	458	461	464	466	28
3.30	469	472	475	478	481	484	487	489	492	495	29
3.40	498	501	503	506	509	512	515	517	520	523	28
3.50	526	529	532	534	537	540	543	546	549	552	29
3.60	555	558	561	564	566	569	572	575	578	581	29
3.70	584	587	590	593	596	599	602	605	608	611	30
3.80	614	618	621	624	627	630	633	636	639	642	32
3.90	648	649	652	656	659	662	665	669	672	675	33
4.00	679	682	685	689	692	695	699	702	706	709	33
4.10	712	716	719	723	726	730	733	736	740	743	35

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE DATE PRINTED 08-03-78

01073500 LAMPREY RIVER NEAR NEWMARKET, NH TYPE LOGISCALE OFFSET = 0.11) RATING NO 29

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (STANDARD PRECISION)										DIFF IN Q PER TENTH GH
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
4.20	747	750	754	757	761	764	768	772	775	779	35
4.30	782	786	789	793	797	800	804	807	811	815	36
4.40	818	822	826	829	833	837	840	844	848	851	37
4.50	855	859	862	866	870	874	877	881	885	889	37
4.60	892	896	900	904	908	911	915	919	923	927	39
4.70	931	934	938	942	946	950	954	958	962	966	39
4.80	970	973	977	981	985	989	993	997	1000	1010	40
4.90	1010	1010	1020	1020	1030	1030	1030	1040	1040	1050	40
5.00	1050	1050	1060	1060	1070	1070	1070	1080	1080	1090	40
5.10	1090	1090	1100	1100	1110	1110	1120	1120	1120	1130	40
5.20	1130	1140	1140	1140	1150	1150	1150	1160	1160	1170	40
5.30	1170	1170	1180	1180	1190	1190	1190	1200	1200	1210	40
5.40	1210	1210	1220	1220	1220	1230	1230	1240	1240	1240	40
5.50	1250	1250	1260	1260	1260	1270	1270	1280	1280	1280	40
5.60	1290	1290	1300	1300	1300	1310	1310	1320	1320	1330	40
5.70	1330	1330	1340	1340	1350	1350	1350	1360	1360	1370	40
5.80	1370	1370	1380	1380	1390	1390	1400	1400	1400	1410	40
5.90	1410	1420	1420	1420	1430	1430	1440	1440	1450	1450	40
6.00	1450	1460	1460	1470	1470	1470	1480	1480	1480	1490	40
6.10	1490	1500	1500	1500	1510	1510	1520	1520	1520	1530	40
6.20	1530	1540	1540	1540	1550	1550	1560	1560	1560	1570	40
6.30	1570	1580	1580	1580	1590	1590	1600	1600	1600	1610	40
6.40	1610	1620	1620	1620	1630	1630	1640	1640	1640	1650	40
6.50	1650	1660	1660	1660	1670	1670	1680	1680	1680	1690	40
6.60	1690	1700	1700	1710	1710	1710	1720	1720	1730	1730	40
6.70	1730	1740	1740	1750	1750	1750	1760	1760	1770	1770	50
6.80	1780	1780	1780	1790	1790	1800	1800	1800	1810	1810	40
6.90	1820	1820	1830	1830	1830	1840	1840	1850	1850	1860	40
7.00	1860	1870	1870	1880	1880	1890	1890	1900	1900	1900	50
7.10	1910	1910	1920	1920	1930	1930	1940	1940	1950	1950	50
7.20	1960	1960	1970	1970	1980	1980	1990	1990	2000	2000	50
7.30	2010	2010	2010	2020	2020	2030	2030	2040	2040	2050	40
7.40	2050	2060	2060	2070	2070	2080	2080	2090	2090	2100	50
7.50	2100	2110	2110	2120	2120	2130	2130	2140	2140	2150	50
7.60	2150	2160	2160	2170	2170	2180	2180	2190	2190	2200	50
7.70	2200	2210	2210	2220	2220	2230	2230	2240	2240	2250	50
7.80	2250	2260	2260	2270	2270	2280	2280	2290	2290	2300	50
7.90	2300	2310	2310	2320	2320	2330	2330	2340	2340	2350	50
8.00	2350	2360	2360	2370	2380	2380	2390	2390	2400	2400	60
8.10	2410	2410	2420	2420	2430	2430	2440	2440	2450	2460	50
8.20	2460	2470	2470	2480	2480	2490	2490	2500	2500	2510	50
8.30	2510	2520	2530	2530	2540	2540	2550	2550	2560	2560	60

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE DATE PRINTED 08-03-78

01073500 LAMPREY RIVER NEAR NEWMARKET, NH TYPE LOG(SCALE OFFSET = 0.111) RATING NO 29

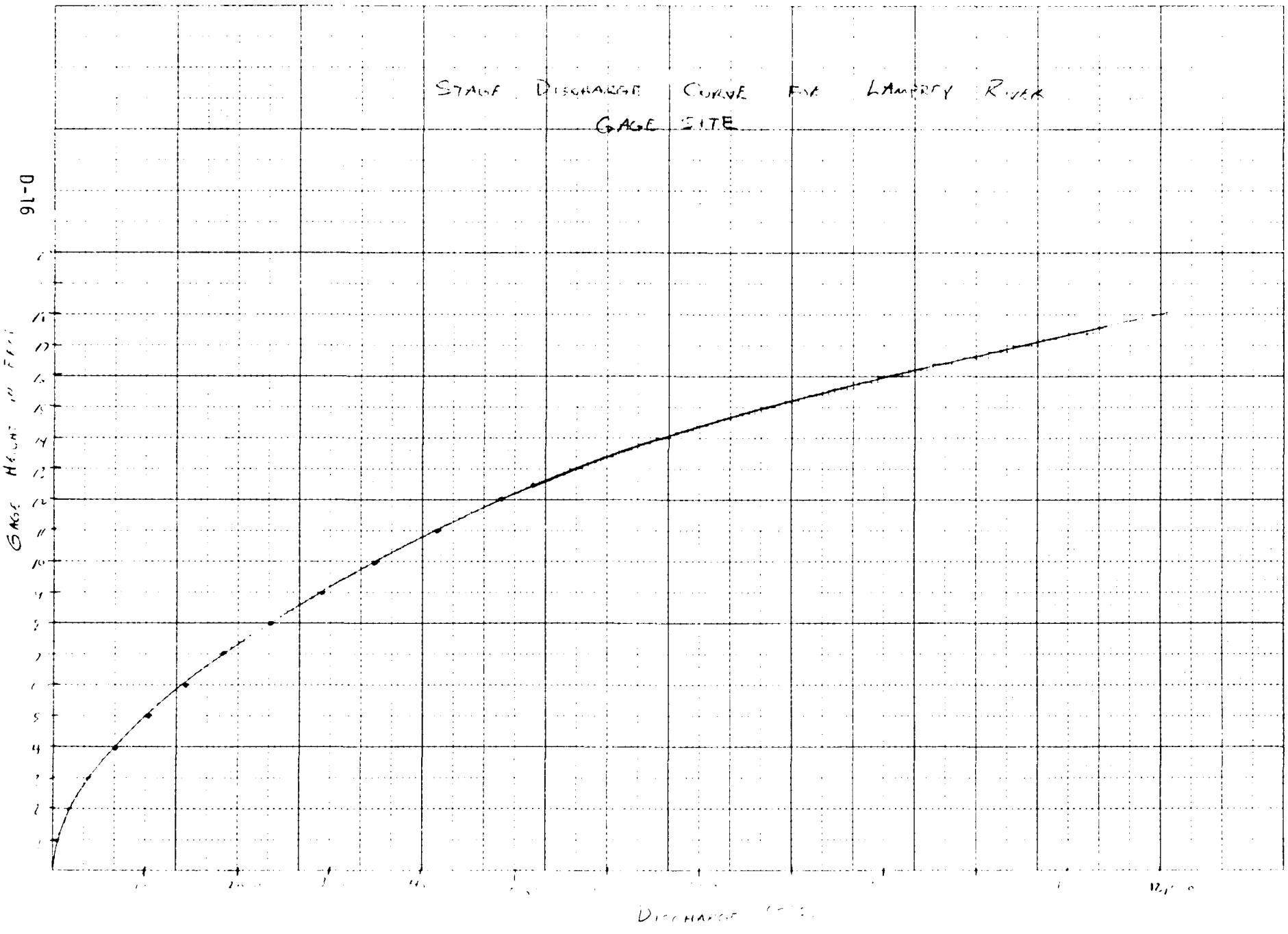
GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (STANDARD PRECISION)										DIFF IN Q PER TENTH GH
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
8.40	2570	2570	2580	2580	2590	2600	2600	2610	2610	2620	50
8.50	2620	2630	2630	2640	2650	2650	2660	2660	2670	2670	60
8.60	2680	2680	2690	2700	2700	2710	2710	2720	2720	2730	50
8.70	2730	2740	2750	2750	2760	2760	2770	2770	2780	2790	60
8.80	2790	2800	2800	2810	2810	2820	2820	2830	2840	2840	60
8.90	2850	2850	2860	2860	2870	2880	2880	2890	2890	2900	60
9.00	2910	2910	2920	2920	2930	2930	2940	2950	2950	2960	50
9.10	2960	2970	2970	2980	2990	2990	3000	3000	3010	3020	60
9.20	3020	3030	3030	3040	3040	3050	3060	3060	3070	3070	60
9.30	3080	3090	3090	3100	3100	3110	3120	3120	3130	3130	60
9.40	3140	3150	3150	3160	3160	3170	3180	3180	3190	3190	60
9.50	3200	3210	3210	3220	3220	3230	3240	3240	3250	3250	60
9.60	3260	3270	3270	3280	3280	3290	3300	3300	3310	3310	60
9.70	3320	3330	3330	3340	3350	3350	3360	3360	3370	3380	60
9.80	3300	3390	3390	3400	3410	3410	3420	3430	3430	3440	60
9.90	3440	3450	3460	3460	3470	3480	3480	3490	3490	3500	70
10.00	3510	3510	3520	3530	3530	3540	3540	3550	3560	3560	60
10.10	3570	3580	3580	3590	3590	3600	3610	3610	3620	3630	60
10.20	3630	3640	3650	3650	3660	3660	3670	3680	3680	3690	70
10.30	3700	3700	3710	3720	3720	3730	3740	3740	3750	3750	60
10.40	3760	3770	3770	3780	3790	3790	3800	3810	3810	3820	70
10.50	3830	3830	3840	3850	3850	3860	3870	3870	3880	3880	60
10.60	3890	3900	3900	3910	3920	3920	3930	3940	3940	3950	70
10.70	3960	3960	3970	3980	3980	3990	4000	4000	4010	4020	60
10.80	4020	4030	4040	4040	4050	4060	4060	4070	4080	4080	70
10.90	4090	4100	4100	4110	4120	4120	4130	4130	4140	4150	60
11.00	4150	4160	4170	4170	4180	4190	4190	4200	4210	4210	70
11.10	4220	4230	4230	4240	4250	4250	4260	4270	4270	4280	70
11.20	4290	4300	4300	4310	4320	4320	4330	4340	4340	4350	70
11.30	4360	4360	4370	4380	4380	4390	4400	4400	4410	4420	60
11.40	4420	4430	4440	4440	4450	4460	4460	4470	4480	4490	70
11.50	4490	4500	4510	4510	4520	4530	4530	4540	4550	4550	70
11.60	4560	4570	4570	4580	4590	4600	4600	4610	4620	4620	70
11.70	4630	4640	4640	4650	4660	4660	4670	4680	4690	4690	70
11.80	4700	4710	4710	4720	4730	4730	4740	4750	4760	4760	70
11.90	4770	4780	4780	4790	4800	4810	4810	4820	4830	4830	70
12.00	4840	4850	4850	4860	4870	4880	4880	4890	4900	4900	70
12.10	4910	4920	4930	4930	4940	4950	4950	4960	4970	4980	70
12.20	4980	4990	5000	5000	5010	5020	5030	5030	5040	5050	70
12.30	5050	5060	5070	5080	5080	5090	5100	5110	5110	5120	80
12.40	5130	5130	5140	5150	5160	5160	5170	5180	5190	5190	70

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

EXPANDED RATING TABLE DATE PRINTED 08-03-78

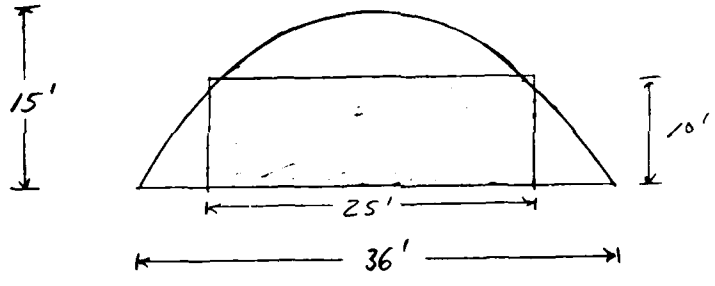
01073500 LAMPREY RIVER NEAR NEWMARKET, NH TYPE LOG(SCALE OFFSET = 0.11) RATING NO 29

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (STANDARD PRECISION)									DIFF IN Q PER TENTH GH
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
12.50	5200										



Downstream Flooding (cont.)

About 200' downstream of the stream gauging site is a concrete arch bridge crossing which is sketched in the picture below. The stream gradient increases sharply in this reach, and water flows rapidly over a rock streambed. The storm of 1977 (5,200 cfs) caused the arch opening to fill about half way, so based on this high water mark and the surrounding conditions, a 25 foot wide by 10 foot high box was used to approximate the bridge opening. The rating table for this section is shown on the next page.



Box Opening 25' x 10'

slope = .1

Channel n = 0.3

===== DATA FOR THE COMBINED SYSTEM =====

DEPTH ft.	ELEV ft.	AREA ft↑2	WPER ft.	HYD-R ft.	AR2/3	Q cfs
0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.50	0.5	12.5	26.0	0.5	7.7	120.5
1.00	1.0	25.0	27.0	0.9	23.7	373.0
1.50	1.5	37.5	28.0	1.3	45.6	715.6
2.00	2.0	50.0	29.0	1.7	71.9	1129.2
2.50	2.5	62.5	30.0	2.1	101.9	1601.3
3.00	3.0	75.0	31.0	2.4	135.2	2122.9
3.50	3.5	87.5	32.0	2.7	171.1	2687.4
4.00	4.0	100.0	33.0	3.0	209.4	3289.1
4.50	4.5	112.5	34.0	3.3	249.8	3923.6
5.00	5.0	125.0	35.0	3.6	292.1	4587.3
5.50	5.5	137.5	36.0	3.8	336.0	5277.0
6.00	6.0	150.0	37.0	4.1	381.4	5990.1
6.50	6.5	162.5	38.0	4.3	428.1	6724.4
7.00	7.0	175.0	39.0	4.5	476.1	7477.8
7.50	7.5	187.5	40.0	4.7	525.2	8248.6
8.00	8.0	200.0	41.0	4.9	575.3	9035.4
8.50	8.5	212.5	42.0	5.1	626.3	9836.8
9.00	9.0	225.0	43.0	5.2	678.2	10651.6
9.50	9.5	237.5	44.0	5.4	730.8	11478.7
10.00	10.0	250.0	45.0	5.6	784.2	12317.3

Packers Falls Bridge Rating Table

From the bridge rating table a prefailure flow of 4650 cfs would create a stage of 5.0 feet. A failure outflow of 9890 cfs would create a stage of 8.5 feet.

Of the four houses located in the reach between the dam and Packers Falls Bridge, two are in danger of being flooded. About 2200 feet downstream of the dam, one house is 15 feet above the streambed. If flood stages for the gauging site can be assumed to apply here, a prefailure flow would have a stage of 11.8 feet, but it would rise to 16.6 feet after failure. This would probably cause damage and there is a possibility of loss of life.

The other house affected by flooding is at the gauging site, 3000' downstream of the dam. It is located 12 feet above the streambed and before failure some minor damage may occur, but at failure, damage is likely and a potential for loss of life exists.

Another 200' downstream of the gauging site the steep gradient of the falls and the arch bridge opening tend to create high velocities but low stage heights. It is expected that the bridge, recently built and in good condition, would be able to survive the failure flow wave.

The Failure Flow Wave is not expected to create any serious damage downstream. The housing in the reach downstream of Packer Falls Bridge is sparse and all buildings are located well above the streambed. The wave will substantially attenuate as the river approaches the sea and the overbanks widen out and become swampy.

Test Flood Analysis

Size Classification: SMALL (height < 25 ft., storage 1000 ac-ft.)

Hazard Classification: SIGNIFICANT based on the possibility of loss of life and probable damage to inhabitable structures.

According to the "Recommended Guidelines" the hazard classification and dam size call for a test flood between the 100 year flood and ½ of the Probable Maximum Flood (PMF). Since the hazard classification is on the low side of significant, we will use the 100 year flood.

Peak Uncontrolled Flow

Available from the U.S. Geological Survey are the results of a peak flow frequency analysis summary for the stream gauging site on the Lamprey River. Shown on the next page is the data summary, showing the WRC estimate of the 100 year flood (.01 annual exceedance probability) using a Log Pearson Type III analysis. On the page following the summary is a computer plot of WRD estimates and observed peaks.

Although the gauge is located downstream of the dam, the differences in drainage areas are negligible, and the same flow rate can be assumed to apply at both sites. From the data summary:

100 year Peak Uncontrolled Flow = 7055 cfs

PGM J407 VER 3.4
(REV 10/22/79)

U. S. GEOLOGICAL SURVEY
ANNUAL PEAK FLOW FREQUENCY ANALYSIS
FOLLOWING WRC GUIDELINES BULL. 17-A.

RUN-DATE 11/ 6/80 AT 1325 SEQ 1.0001

OPTIONS IN EFFECT -- PLOT NOBC LOPT NOOB PPOS NORS EXPR CLIM

STATION - 01073500/USGS LAMPREY RIVER NEAR NEWMARKET, NH 1935-1979 01073500/USGS

INPUT DATA SUMMARY

-- YEARS OF RECORD -- SYSTEMATIC	HISTORIC	HISTORIC PEAKS	GENERALIZED SKEW	SKEW OPTION	GAGE BASE DISCHARGE	USER-SET OUTLIER CRITERIA HIGH OUTLIER	LOW OUTLIER
45	0	0	0.560	WRC WEIGHTED	0.0	--	--

••••••••• NOTICE -- PRELIMINARY MACHINE COMPUTATIONS. •••••••••
••••••••• USER RESPONSIBLE FOR ASSESSMENT AND INTERPRETATION. •••••••••

*CF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE. 0.0
*CF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION. 618.4
*CF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS WERE NOTED.

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE DISCHARGE	FLOOD BASE EXCEEDANCE PROBABILITY	LOGARITHMIC MEAN	LOGARITHMIC STANDARD DEVIATION	LOGARITHMIC SKEW
SYSTEMATIC RECORD	0.0	1.0000	3.3159	0.2059	-0.190
W R C ESTIMATE	0.0	1.0000	3.3159	0.2059	0.360

ANNUAL FREQUENCY CURVE ORDINATES -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

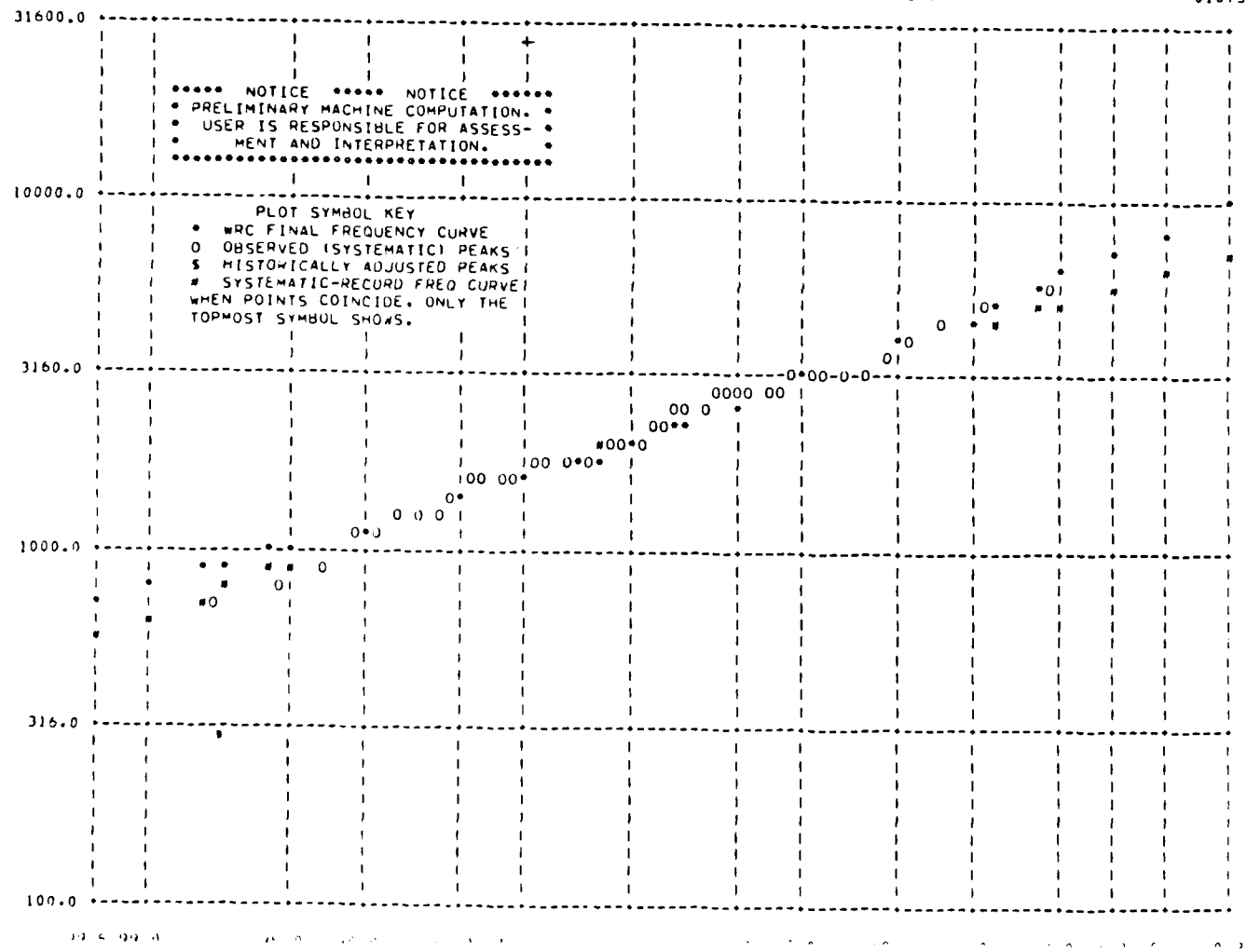
ANNUAL EXCEEDANCE PROBABILITY	W R C ESTIMATE	SYSTEMATIC RECORD	'EXPECTED-PROBABILITY' ESTIMATE	95-PCT CONFIDENCE LIMITS FOR W R C ESTIMATES LOWER	UPPER
0.9950	716.4	561.0	676.0	552.9	867.7
0.9900	779.8	643.3	745.1	611.3	935.0
0.9500	999.1	925.8	977.9	817.9	1165.3
0.9000	1151.5	1117.5	1132.5	964.4	1324.7
0.8000	1380.5	1395.7	1368.4	1186.0	1566.0
0.5000	2011.7	2100.9	2011.7	1785.9	2262.1
0.2000	3052.1	3096.0	3087.0	2693.2	3545.2
0.1000	3858.3	3760.1	3950.8	3342.6	4633.1
0.0400	5017.8	4597.5	5226.4	4229.3	6297.4
0.0200	5988.5	5217.5	6377.0	4442.8	7761.5
0.0100	7055.1	5833.3	7663.1	5704.8	9431.4
0.0050	8230.3	6448.6	9211.5	6523.0	11335.3
0.0020	9971.8	7264.7	11346.9	7703.0	14263.5

PGM J407 VER 3.4
(REV 10/22/79)

U. S. GEOLOGICAL SURVEY
ANNUAL PEAK FLOW FREQUENCY ANALYSIS
FOLLOWING WRC GUIDELINES BULL. 17-A.

RUN-DATE 11/ 6/80 AT 1325 SEQ 1.0001

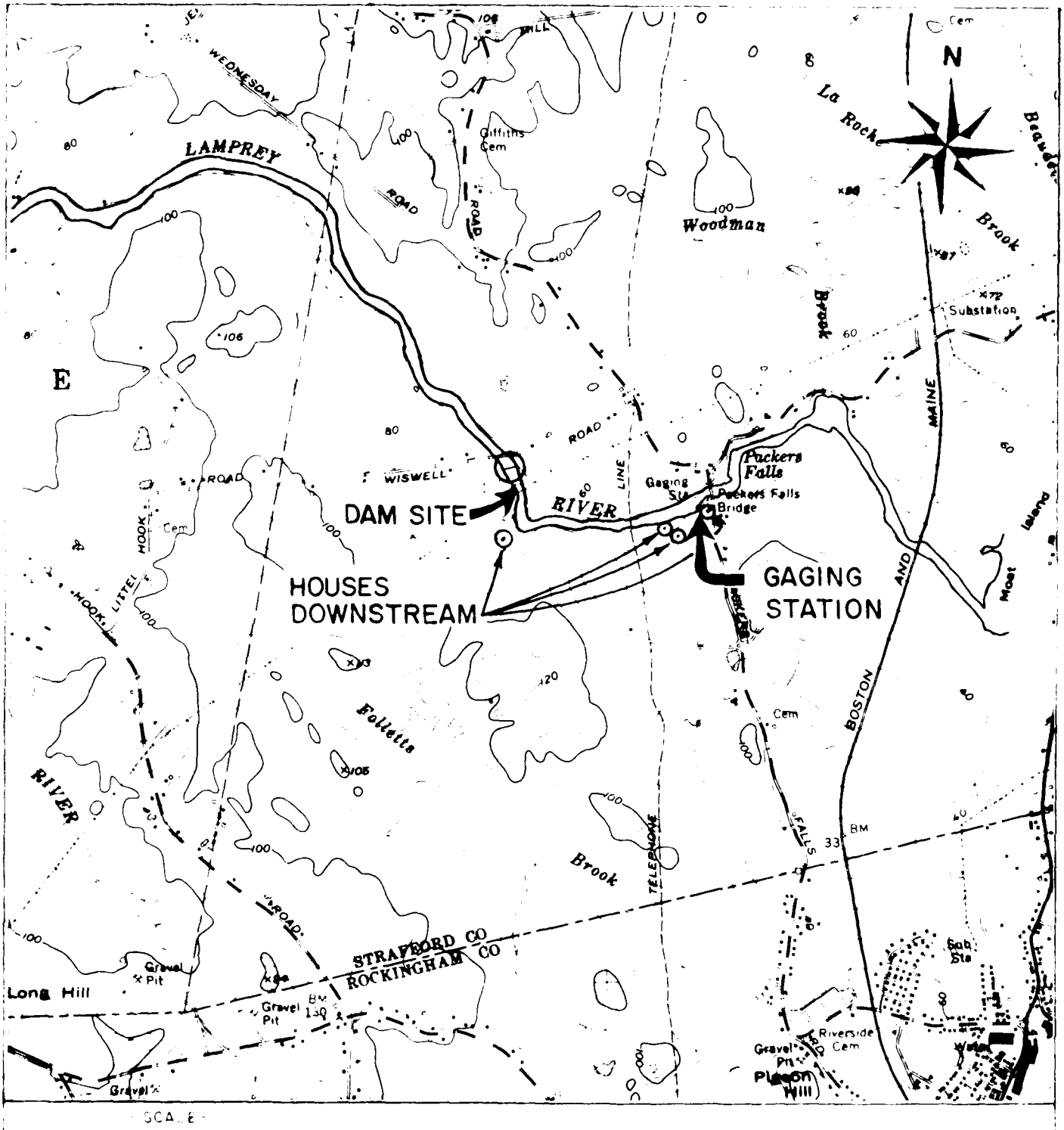
STATION - 01073500/USGS LAMPREY RIVER NEAR NEWMARKET, NH 1935-1979 01073500/USGS



A peak inflow of 7055 cfs would create a stage of about 6.5 feet above the spillway crest, which is 1.7 feet above the left abutment. The peak test flood outflow is:

$$\frac{7055}{4650} (100\%) = 150\%$$

of the spillway capacity with the water surface at the dam crest.



SCALE

2 (MILES)

FROM USGS NEWMARKET NEW HAMPSHIRE QUADRANGLE MAP

GOLDBERG ZOINO & ASSOCIATES, INC
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

US ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION AND DOWNSTREAM HAZARD MAP

FILE No 2605

PACKERS FALLS DAM — DURHAM, NEW HAMPSHIRE

SCALE AS SHOWN

DATE NOV 1980

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
NH	441 NED	NH	0	7	01				PACKERS FALLS DAM	4306.2	7057.8	08DEC80

POPULAR NAME	NAME OF IMPOUNDMENT
	LAMPREY RIVER

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	00	LAMPREY RIVER	NEWMARKET	3.0	3301

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)
PGOT	1911	S	18	18	500	360

DIST OWN FED REG PRV/FED SCS ACT YEAR/DATE
NED N N N N

REMARKS

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
Y	200	U	110	4650												

OWNER	ENGINEERING BY	CONSTRUCTION BY
TOWN OF DURHAM	UNKNOWN	UNKNOWN

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NH ARB	NH ARB

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
GOLDBERG ZOINO & ASSOC INC	02NOV80	PL 92-367

REMARKS

END

FILMED

8-85

DTIC